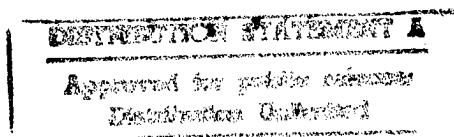CRREL

Resilient Modulus Testing of Materials from Mn/ROAD, Phase 1

Richard L. Berg, Susan R. Bigl, Jeffrey A. Stark
and Glenn D. Durell

September 1996

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Abstract: The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) conducted resilient modulus tests on materials from the Mn/ROAD test site for the Minnesota Department of Transportation. Materials tested included samples of the lean clay subgrade at the site and the two extreme grades of base designed specifically for Mn/ROAD. Some specimens were tested in both frozen and subsequently "thawed" conditions; others were tested at room temperature without ever having been frozen. Researchers performed linear regression analysis on the data to develop equations that predict frozen modulus based on unfrozen water content and unfrozen modulus based on stress, degree of saturation and density. We also reanalyzed data from two previously tested materials. CRREL can use the study's equations in the Mechanistic Pavement Design and Evaluation Procedure under development at CRREL to predict estimated damage in some Mn/ROAD test sections.

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of Engineers**

Cold Regions Research &
Engineering Laboratory

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and Glenn D. Durell

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PREFACE

This report was prepared by Dr. Richard L. Berg, Research Civil Engineer (retired), Susan R. Bigl, Research Physical Scientist, Jeffrey A. Stark, Supervisory Civil Engineering Technician, Civil and Geotechnical Research Division, Research and Engineering Directorate, and Glenn D. Durell, Engineering Technician, Engineering Resources Branch, Technical Resources Center, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire.

This work was funded through Agreement 64632, Task Order 1 with the Minnesota Department of Transportation (Mn/DOT) and a Construction Productivity Advancement Research (CPAR) project between Mn/DOT and CRREL. The authors thank George Cochran of the Minnesota Road Research Project and Dr. Vincent Janoo of CRREL for technically reviewing the manuscript of this report.

This report covers results from the subgrade and two base materials available in 1990 and is considered Phase 1. Additional materials were manufactured later and are described separately as Phase 2 results.

The information reported here is the result of work done by a team of CRREL personnel whose efforts we greatly appreciate. Arthur Peacock, Brian Charest, and David Carbee were all involved in molding, freezing, and milling the specimens. Dale Bull conducted some of the resilient modulus testing. Brian Charest characterized the water content and density subsequent to resilient modulus testing.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

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EXECUTIVE SUMMARY

Laboratory resilient modulus tests were conducted on pavement materials from the Minnesota Road Research Project (Mn/ROAD) to characterize their behavior under seasonal frost conditions, and to provide input necessary for modeling the materials with the Mechanistic Pavement Design and Evaluation Procedure under development at CRREL. Results of other tests to characterize their physical properties (grain-size distribution, specific gravity, Atterberg limits, organic content, hydraulic properties, and compaction) as well as tests more specifically related to freeze/thaw processes (frost susceptibility and unfrozen moisture content) are reported separately (Bigl and Berg 1996a).

The materials reported on here include two samples of the clay subgrade from beneath the Mn/ROAD site (the high-heaving sample 1206 and the low-heaving sample 1232) and the two bases with the least (class 6 special) and greatest (class 3 special) amounts of the fine fraction. When this testing was performed, the two bases with intermediate amounts of fines (class 4 special and class 5 special) were unavailable. However, to conduct subsequent modeling with the Mechanistic Pavement Design and Evaluation Procedure, it was necessary to approximate their behavior using properties of similar materials. Therefore, this report includes modulus test results conducted previously on materials most closely matching the specified size gradations of the class 4 and class 5 special subbases. A subbase from taxiway A at the Albany, New York, airport (Cole et al. 1987) substituted for the class 4 special subbase; dense-graded stone, from a Winchendon, Massachusetts, test site (Cole et al. 1986) substituted for the class 5 special.

Specimens of the materials were molded at a specified moisture/density condition and then saturated. Once saturated, they were frozen with an open system, allowing movement of any additional water required to the freezing front. Specimens were tested using repeated load triaxial procedures at a matrix of applied confining and deviator stresses. Testing was first conducted at three temperatures below freezing, and then specimens were allowed to thaw in the triaxial device and subsequently retested in a thawed, saturated state. The same specimens of the base materials were subsequently tested at room temperature under several moisture contents created by drawing a suction at the base of the specimen. To obtain unfrozen data for the subgrade materials, different specimens were molded to specific moisture conditions and tested at room temperature without ever having been frozen. A different testing machine was used for the unfrozen specimens of the 1206 subgrade than for all other testing. It was discovered after testing was complete that these data include a calibration error of unknown magnitude that produced moduli about an order of magnitude too high.

All materials exhibited a two to three order of magnitude increase in resilient modulus at subfreezing temperatures of −2°C and lower. The modulus of all of the materials was stress dependent and also showed a lower magnitude increase as the degree of saturation decreased. For the materials where a variety of densities were tested, modulus was also dependent on density.

The resilient modulus data from the materials tested in this study were analyzed using statistical regression techniques. Data from the two previously tested materials were also reanalyzed. In the regression analysis, the resilient modulus was the

dependent variable. For the frozen condition, a function of the unfrozen water content was the independent variable; for the thawed/unfrozen condition, various forms and combinations of stress, density, and degree of saturation were the independent variables. The equations resulting from this analysis have been subsequently utilized in the CRREL Mechanistic Pavement Design Procedure to predict estimated damage in some of the test sections at Mn/ROAD. Results of the modeling effort are described in Bigl and Berg (1996b). Another report in this series (Bigl and Berg 1996c) summarizes all the testing and modeling results.

Resilient Modulus Testing of Materials from Mn/ROAD, Phase 1

RICHARD L. BERG, SUSAN R. BIGL, JEFFREY A. STARK AND GLENN D. DURELL

INTRODUCTION

This report describes resilient modulus testing that CRREL conducted on materials from Mn/ROAD for the Minnesota Department of Transportation (Mn/DOT). Results of other tests to determine physical and behavioral characteristics are reported separately (Bigl and Berg 1996a). The materials tested included samples of the subgrade at the site and the two extreme grades of base and subbase designed especially for Mn/ROAD: class 6 special, a clean base material, and class 3 special, a subbase material with a high percentage of fines. Some specimens were tested in both frozen and subsequently thawed conditions; others were tested at room temperature without ever having been frozen. Two intermediate grades of base—class 4 special, class 5 special, and an R-70 subgrade—were manufactured later and results of their testing are described in Berg (in prep.).

The resilient modulus tests were conducted using repeated-load triaxial test procedures described by Cole et al. (1985, 1986). The tests involve applying a confining pressure to a cylindrical specimen within a cell, while also applying a cyclical loading of a deviator stress to the top end of the specimen. The resilient modulus is defined as the applied deviator stress divided by the recovered strain upon unloading (the resilient axial strain) for a representative loading cycle.

Linear regression analyses were performed on the resilient modulus data from the materials tested in this study. Data from two previously tested materials that are similar to the intermediate grades of base/subbase materials (class 4 special and class 5 special) that will be used at Mn/ROAD were reanalyzed. In the regression analysis, the resilient modulus was the dependent variable and various forms and combinations of stress, density, and degree of saturation were the independent variables. The equations resulting from this analysis have been subsequently utilized in the mechanistic pavement design procedure under development at CRREL to predict estimated damage that would occur in some of the Mn/ROAD test sections. Results of the modeling effort are described in Bigl and Berg (1996b).

METHODS

Materials/conditions tested

The materials tested included the two extreme grades of base—class 6 special and class 3 special, and the 1206 and 1232 subgrade samples that represent, respectively, the high- and low-heaving sandy lean clay (CL) subgrades. Specimens of the base materials were tested in a frozen saturated condition at three temperatures (class 6 special at –5.0°, –3.0°, and –2.0°C; class 3 special at –7.0°, –5.0°, and –2.0°C). The same specimens were subsequently warmed to above freezing and tested again at various thawed conditions in a range of moisture levels created by drawing a suction at the base of the specimens. Frozen, saturated subgrade specimens were similarly tested at three temperatures below freezing (–7.0°, –5.0°, and –2°C) and also tested subsequently in a thawed, saturated state at room temperature. To acquire above-freezing resilient modulus data for the subgrade samples at various moisture contents, we molded specimens to specified conditions and

Table 1. Samples tested for resilient modulus.

	Condition		
Material	Frozen	Thawed*	Never frozen
Sandy lean clay subgrade (CL)			
1206 (high heave)	4	4[†]	24
1232 (low heave)	8	8[†]	18
Class 3 stockpile	5	4[**]	
Class 6 stockpile	7	6[**]	
Total	24		42

* Same samples were tested in the frozen and thawed condition
[†] Samples tested only in the thawed, undrained condition
[**] Thawed samples were tested at several moisture contents

tested at room temperature. We refer to these as a "never frozen" specimens. Specimens of the low-heaving subgrade (1232) included replicates of various moisture contents at a single density; for the high-heaving subgrade (1206), replicates were made with variation in both moisture and density conditions. A total of 66 specimens were prepared (Table 1).

Specimen preparation

The specimen size used for the subgrades and the class 3 special subbase was 5.1 cm (2 in.) diam. and 12.7 cm (5 in.) long. The coarser class 6 special material was tested using specimens measuring 15.2 cm (6 in.) in diam. and 39.4 cm (15.5 in.) in length. Gradation curves and other physical properties of these materials are in Bigl and Berg (1996a).

Specimens that were tested in frozen/thawed conditions were first molded at the specified moisture/density condition, which was usually at optimum as determined from the compaction testing. The subgrade specimens were compacted with a CE-12 (Standard Proctor) compaction effort, while the class 3 special and class 6 special were compacted with a CE-55 (Modified Proctor) effort to approximate anticipated in-situ conditions (Table 2). The specimens were then prepared in a manner similar to the procedure used in the frost susceptibility test (Chamberlain 1987). They were set on a special base with a porous stone and saturated from the base up with a constant head water supply. Once saturated, the specimens and their porous-stone bases were positioned with two other

special plates that could circulate temperature-regulated fluid at the top and bottom. The bottom porous plate allowed movement of any additional water required for open system freezing. The fluid temperatures were set to allow freezing from the top down at the rate of about 2.5 cm (1 in.) per day. The specimens were frozen with a surcharge of 3.4 kPa (0.5 lb/in.^{2}) placed on the upper cold plate; this weight simulates the weight of a 15.2-cm (6-in.)-thick asphalt concrete pavement surface.

After freezing was complete, the specimen ends were trimmed to assure that they were smooth and flat. For the subgrade specimens, this was done by milling the ends flat. For the base and subbase materials, we made a slurry of fine material that was placed in custom-made equipment similar to that used for capping concrete specimens with molten sulfur. The slurry was then frozen to the ends of the specimen and milled flat and smooth.

Subgrade specimens tested at room temperature without being frozen were molded at the specified moisture/density levels, trimmed with a knife, and tested immediately. For the Sample 1232 subgrade, the density was held constant at about 1.76 Mg/m^3 (110 lb/ft^3) and the moisture content was varied from 13% to a saturated value of 20%, by weight (Table 2). For the 1206 subgrade, specimens were prepared at three compactive efforts, with moisture contents intended to be at three conditions: optimum, 2% above optimum, and 2% below optimum (Table 2).

Test procedures

The resilient modulus tests were conducted using repeated-load triaxial test procedures, the details of which are described in reports by Cole et al. (1985 and 1986). Testing was accomplished in triaxial cells that were constructed to accommodate the instrumentation used to monitor load and deformation (Fig. 1). Separate cells were used for the 5.1- and 15.2-cm (2- and 6-in.)-diam. specimens. The triaxial cells were designed so that the cell base could be removed from the rest of the major cell components. In this way, a specimen could remain on its base while the remainder of the assembly was used on other specimens in a rotating sequence. A miniature, high-precision load cell mounted in the

triaxial cell on the loading piston was used to monitor the load applied to the specimen.

The axial deformation was monitored using two LVDTs, or linear variable displacement transducers, mounted on hinged arms. The LVDT assemblies were mounted on two circumferential rings clamped around the specimen. Radial deformation was also monitored using three noncontacting multi-VITs (variable impedance transducers) spaced evenly around the specimen at its midpoint. These pointed at small aluminum foil targets positioned on the specimen.

Table 2. Resilient modulus samples tested.

Subgrade 1206

No.	Dry density Mg/m^3 (lb/ft^3)	Water content (% by wt)
Never frozen		
5K Compactive effort*		
18A	1.77 (110.3)	13.7
18B	1.72 (107.4)	15.9
18C	1.69 (105.3)	16.1
21B	1.70 (106.4)	19.7
21C	1.70 (106.1)	17.3
22A	1.69 (108.4)	19.0
22B	1.73 (108.0)	19.1
22C	1.74 (108.6)	18.3
CE 12 Compactive effort		
16A	1.69 (105.6)	13.5
16B	1.67 (104.4)	14.1
16C	1.89 (118.1)	14.3
18A	1.69 (105.4)	17.4
18B	1.71 (106.9)	15.9
18C	1.72 (107.3)	15.9
20A	1.69 (105.8)	18.5
20C	1.70 (106.1)	17.8
CE 55 Compactive effort		
13A	1.74 (108.5)	11.0
13B	1.68 (105.1)	10.6
15A	1.88 (117.3)	13.9
15B	1.82 (113.9)	13.4
15C	1.85 (115.7)	13.5
17A	1.82 (113.9)	14.9
17B	1.86 (116.1)	14.9
17C	1.84 (114.9)	14.4
Frozen/thawed (saturated)		
CE 12 Compactive effort		
M5-1A	1.71 (106.5)	22.6
M5-1B	1.67 (104.1)	24.1
M5-2A	1.68 (104.6)	23.4
M5-2B	1.70 (106.0)	22.8

Subgrade 1232

No.	Dry density Mg/m^3 (lb/ft^3)	Water content (% by wt)
Never frozen		
CE 55 Compactive effort		
14A	1.76 (109.8)	13.1
14B	1.78 (111.4)	12.9
14C	1.78 (111.4)	13.0
15A	1.78 (111.0)	14.4
15B	1.77 (110.8)	14.1
15C	1.79 (112.0)	13.8
15D	1.77 (110.3)	14.3
16A	1.76 (109.9)	15.7
16B	1.75 (109.0)	15.7
16C	1.76 (110.0)	15.6
16D	1.77 (110.7)	15.5
18A	1.75 (109.3)	17.5
18B	1.75 (109.5)	17.5
18C	1.76 (109.9)	17.5
18D	1.76 (110.0)	17.2
S1	1.70 (106.1)	20.5
S2	1.68 (104.7)	21.3
S3	1.70 (106.3)	20.3
Frozen/thawed (saturated)		
CE 12 Compactive effort		
M4-1A	1.73 (107.8)	18.9
M4-1B	1.72 (107.5)	18.8
M4-2A	1.71 (106.6)	19.3
M4-2B	1.72 (107.6)	18.3
M6-1A	1.69 (105.6)	18.9
M6-1B	1.72 (107.1)	19.2
M6-3A	1.68 (104.7)	19.4
M6-3B	1.68 (104.7)	20.2

* 5K compactive effort = 5,000 ft-lb/ft^3 applied in layers similar to the CE 12 and CE 55 test methods.

Table 2 (cont'd). Resilient modulus samples tested.

Class 3 Subbase			Class 6 Base Course		
No.	Dry density Mg/m^3 (lb/ft^3)	Water content (% by wt)	No.	Dry density Mg/m^3 (lb/ft^3)	Water content (% by wt)
Thawed			**Thawed**		
CE 55 Compactive effort			CE 55 Compactive effort		
Class 3-1	2.11 (131.5)	7.2	Class 6-2	2.08 (130.0)	9.6
	2.12 (132.1)	3.3		2.08 (130.0)	6.0
	2.12 (132.3)	0.8			
			Class 6-3	2.06 (128.4)	10.1
Class 3-2R	2.13 (132.7)	5.1		2.06 (128.4)	8.9
	2.12 (132.6)	3.2		2.09 (130.7)	7.3
	2.12 (132.3)	0.8			
			Class 6-4	2.09 (130.6)	9.5
Class 3-3	2.09 (130.4)	8.3		2.09 (130.6)	7.5
	2.10 (131.2)	6.7		2.14 (133.8)	7.2
	2.10 (130.9)	2.1		2.14 (133.8)	6.5
	2.10 (131.4)	1.4			
			Class 6-5	2.06 (128.7)	9.3
Class 3-4	2.08 (129.6)	9.3		2.06 (128.7)	7.1
	2.09 (129.8)	7.9		2.05 (128.2)	5.1
	2.09 (130.5)	4.0		2.05 (128.2)	4.8
	2.10 (131.0)	2.4		2.10 (131.0)	2.4
Frozen			Class 6-6	2.13 (133.1)	8.9
Class 3-1	2.06 (128.3)	7.6		2.18 (136.0)	4.9
Class 3-2	2.09 (130.7)	6.2		2.18 (136.0)	4.4
Class 3-3	2.03 (126.5)	9.3		2.14 (133.3)	1.6
Class 3-4	2.02 (125.8)	10.1		2.14 (133.8)	0.7
			Class 6-9	2.10 (134.2)	8.2
				2.08 (136.2)	7.0
				2.06 (136.2)	6.1
				2.09 (136.2)	5.4
				2.17 (135.3)	4.0
				2.17 (135.3)	1.4
				2.18 (136.3)	0.5
			Frozen		
			Class 6-1	2.10 (130.9)	9.4
			Class 6-2	2.08 (130.0)	9.6
			Class 6-3	2.06 (128.4)	10.1
			Class 6-4	2.09 (130.6)	9.5
			Class 6-6	2.13 (133.1)	8.9
			Class 6-9	2.15 (134.2)	8.2

The specimen was first positioned on one of the cell bases with an aluminum cap placed on top. It was then encased in a thin latex membrane with O-rings at the top and bottom. The aluminum foil targets for the multi-VITs were secured to this first membrane, then a second membrane was placed over the first to protect the multi-VITs. The remainder of the instrumentation was then attached to the specimen and cell in the necessary positions. Once the cell was assembled, the specimen was tested in repeated-load triaxial compression using a closed-loop, electrohydraulic testing machine.
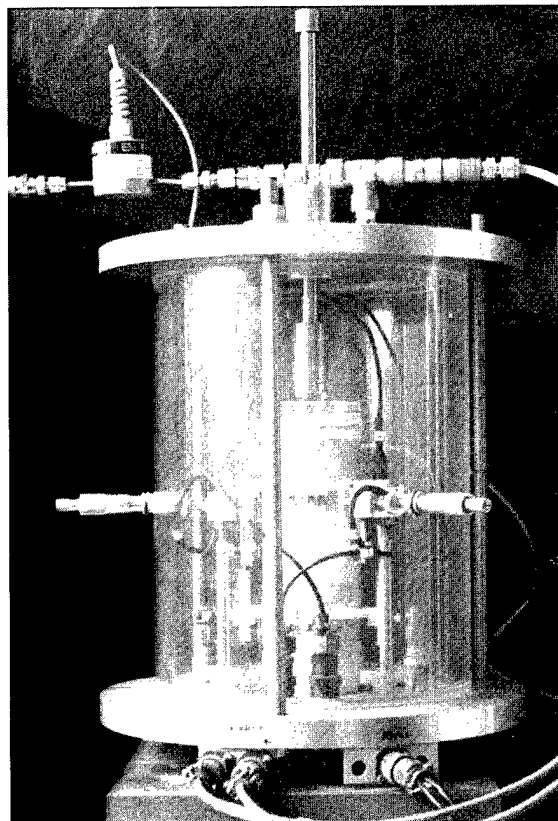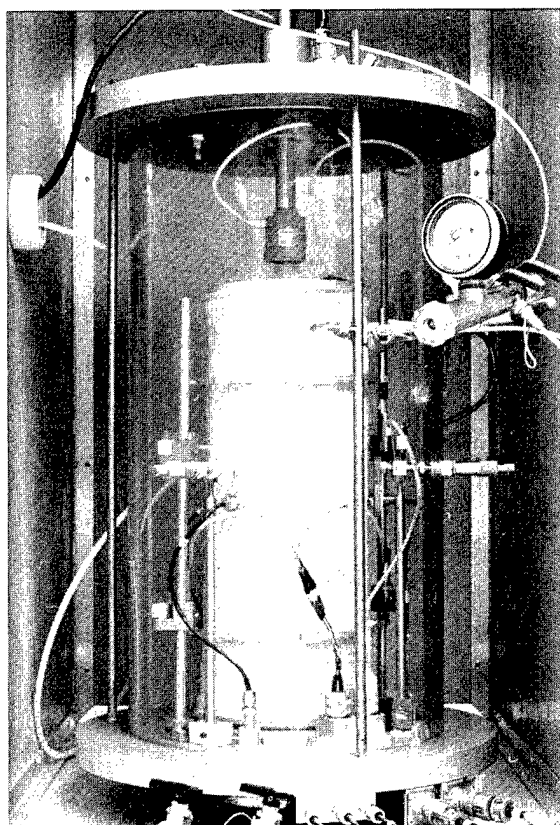
Figure 1. Examples of triaxial cells. Cells for 15.2- (left) and 5.1-cm-diam. specimens.
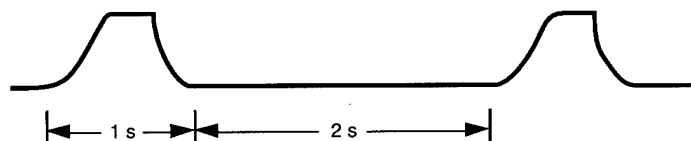
Figure 2. Waveform used in Mn/ROAD resilient modulus testing.

For this study, the waveform used to apply the cyclic deviator stress was the waveform shown in Figure 2. The pulse length is approximately 1 second with 2 seconds between pulses. Table 3a illustrates the sequence of stress conditions applied to the unfrozen specimens, whether thawed or never frozen. We applied only the stress combinations that would avoid excessive permanent strains in the specimens (5% decrease in axial length), depending on the moisture condition and estimated available strength. The frozen specimens were tested holding the confining pressure constant at 69 kPa (10 lb/in.^{2}) and varying the deviator stress as shown in Table 3b. The frozen specimens were tested at three temperatures: class 6 special specimens were tested at approximately –5.0°, –3.0°, and

–2.0°C (23.0°, 26.6° and 28.5°F); all other specimens were tested at –7.0°, –5.0°, and –2.0°C (19.5°, 23.0° and 28.5°F). The cyclical deviator stress was applied at each test point until the resilient axial strain remained a constant value, which occurred at about 70–100 applied cycles.

Once the tests on the frozen specimens were completed, they were allowed to thaw in the triaxial device and subsequently retested in a thawed, saturated state. For the coarser-grained materials, the specimens were then allowed to drain in place, and tested again. Increasing amounts of suction were applied to the base and subbase specimens to bring them to various moisture states, and additional test points were determined.

Previously tested materials

In order to conduct the follow-on modeling of predicted damage at the test sections of the Mn/ROAD facility, resilient modulus characterization was needed for two additional Mn/DOT subbase materials, class 4 special and class 5 special. We looked through CRREL's collection of material

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Table 3. Stress conditions of resilient modulus tests in current study.

Confining pressure σ_3, kPa (lb/in.^{2})	Deviator stress σ_d, kPa (lb/in.^{2})	Stress ratio (σ_1/σ_3)
a. Thawed or never-frozen specimens		
48.3 (7)	48.3 (7.0)	2.0
48.3 (7)	34.5 (5.0)	1.7
48.3 (7)	27.6 (4.0)	1.6
48.3 (7)	20.7 (3.0)	1.4
48.3 (7)	13.8 (2.0)	1.3
48.3 (7)	6.9 (1.0)	1.1
48.3 (7)	3.4 (0.5)	1.1
27.6 (4)	48.3 (7.0)	2.8
27.6 (4)	34.5 (5.0)	2.3
27.6 (4)	27.6 (4.0)	2.0
27.6 (4)	20.7 (3.0)	1.8
27.6 (4)	13.8 (2.0)	1.5
27.6 (4)	6.9 (1.0)	1.3
27.6 (4)	3.4 (0.5)	1.1
13.8 (2)	34.5 (5.0)	3.5
13.8 (2)	27.6 (4.0)	3.0
13.8 (2)	20.7 (3.0)	2.5
13.8 (2)	13.8 (2.0)	2.0
13.8 (2)	6.9 (1.0)	1.5
13.8 (2)	3.4 (0.5)	1.3
6.9 (1)	34.5 (5.0)	6.0
6.9 (1)	27.6 (4.0)	5.0
6.9 (1)	20.7 (3.0)	4.0
6.9 (1)	13.8 (2.0)	3.0
6.9 (1)	6.9 (1.0)	2.0
6.9 (1)	3.4 (0.5)	1.5
b. Frozen specimens		
69 (10)	34 (5)	–
69 (10)	69 (10)	–
69 (10)	103 (15)	–
69 (10)	138 (20)	–
69 (10)	207 (30)	–
69 (10)	276 (40)	–
69 (10)	345 (50)	–
69 (10)	483 (70)	–
69 (10)	621 (90)	–
69 (10)	690 (100)	–

Notes:
Thawed samples: each combination of stresses normally used at each moisture condition.
Frozen samples: each combination of stresses normally used at each of three temperatures.

Table 4. Stress conditions of resilient modulus tests—previous study.

Confining pressure σ_3, kPa (lb/in.^{2})	Deviator stress σ_d, kPa (lb/in.^{2})	Stress ratio (σ_1/σ_3)
a. Thawed specimens		
6.9 (1)	3.4 (0.5)	1.5
13.8 (2)	6.9 (1.0)	1.5
27.6 (4)	13.8 (2.0)	1.5
48.3 (7)	24.1 (3.5)	1.5
69.0 (10)	34.5 (5.0)	1.5
6.9 (1)	6.9 (1.0)	2.0
13.8 (2)	13.8 (2.0)	2.0
27.6 (4)	27.6 (4.0)	2.0
48.3 (7)	48.3 (7.0)	2.0
69.0 (10)	69.0 (10.0)	2.0
6.9 (1)	10.3 (1.5)	2.5
13.8 (2)	20.7 (3.0)	2.5
27.6 (4)	41.4 (6.0)	2.5
48.3 (7)	72.4 (10.5)	2.5
69.0 (10)	103.4 (15.0)	2.5
b. Frozen specimens		
69 (10)	60 (9)	–
69 (10)	138 (20)	–
69 (10)	207 (30)	–
69 (10)	276 (40)	–
69 (10)	345 (50)	–
69 (10)	483 (70)	–
69 (10)	621 (90)	–
69 (10)	827 (120)	–

types for which resilient modulus data were available and found the two materials that most closely fit Mn/DOT's specifications for size gradation (Fig. 3). A dense-graded stone tested at a cooperative study in Winchendon, Massachusetts, most closely matched the specifications of the class 5 special material; a subbase material from taxiway A at the Albany, New York, airport most closely matched the class 4 special specifications (Bigl and Berg 1996a).

The methods used during the testing of these materials were nearly identical to the methods of this study. Details of the testing procedures for dense-graded stone are described in Cole et al. (1986) and the procedures for Albany taxiway A subbase are in Cole et al. (1987). Both materials were molded into 15.2-cm (6-in.)-diam. specimens in the laboratory from bulk field samples and then
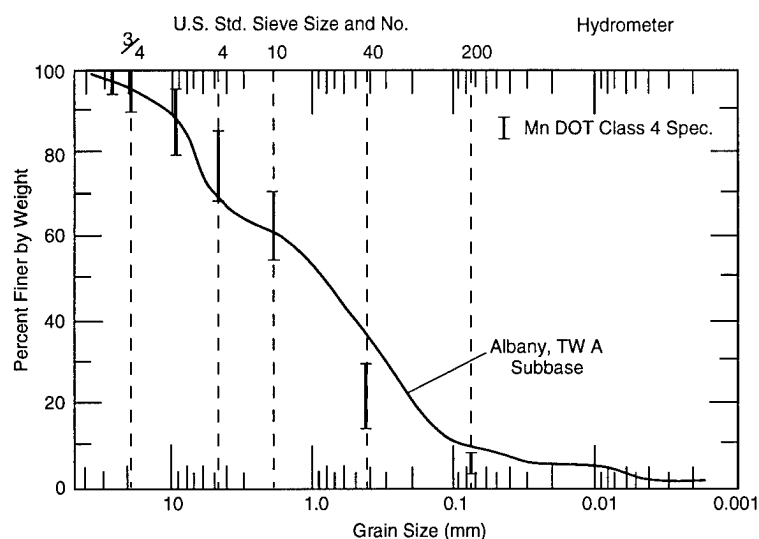
a. Albany, New York, taxiway A sub-base/class 4 special subbase.
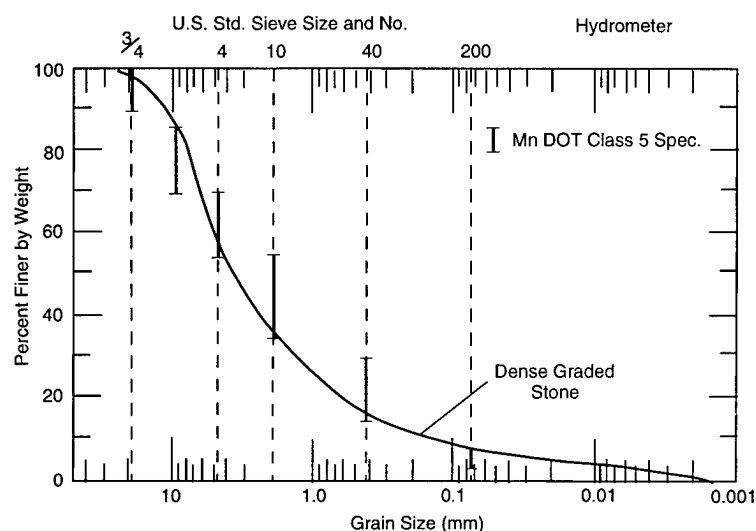
b. Dense-graded stone, Winchendon, Massachusetts/class 5 special subbase.

Figure 3. Comparison of Mn/DOT specifications with size gradations of substitute materials.

frozen from the top down at 2.5 cm (1 in.) per day with open system freezing. This procedure differs from the current study in that the specimens were not saturated prior to freezing. Another difference in this prior testing is the sequence of stresses applied to the specimens (Table 4). In this case also, the stress combinations applied were those that would avoid excessive permanent strains in the specimens (5% axial length shortening).

The previous regression analysis of the resilient modulus data obtained from this earlier test-ing had been based on characterizing the moisture level of the unfrozen material with the measured moisture tension. The data were reanalyzed using degree of saturation as the indicator of moisture condition.

DATA REDUCTION AND ANALYSIS

For each set of applied deviator and confining stresses, the resilient and permanent axial and ra-

dial strains were recorded, and thus were used to calculate a resilient modulus and Poisson's ratio. The resilient modulus is defined as the applied deviator stress divided by the strain recovered upon unloading for a representative loading cycle, or resilient axial strain. To calculate the resilient axial strain, the measured resilient axial deformation is divided by the gauge length over which it is determined. Poisson's ratio is defined as the recoverable radial strain divided by the recoverable axial strain.

The following data were then tabulated in a spreadsheet: confining stress, deviator stress, resilient axial strain, resilient radial strain, density, and moisture condition or temperature. The tables in Appendix A contain these data along with the calculated results. The equivalent data for the previously tested materials are given in Appendix B. These tables also show the actual stress combinations applied to each specimen.

The frozen and unfrozen data were analyzed separately using statistical regression techniques. The nonlinear form of the equation used to model the resilient modulus was the same in both cases, as given by

$$M_r = K_1 P^{K_2} , \qquad (1)$$

where K_1 and K_2 are constants and P is a governing parameter. This equation was linearized by taking the natural log of both sides, resulting in an equation of the form

$$\ln M_r = A_0 + A_1 \ln P , \qquad (2)$$

where A_0 and A_1 are constants. To conduct the regression, the natural log of the modulus was set as the dependent variable and the natural log of the governing parameter was set as the independent variable. In this general case,

$$K_2 = A_1 \quad \text{and} \quad K_1 = e^{A_0} .$$

Frozen

In attempting to represent the frozen data with the general form eq 1, we tried three different governing parameters, all related to the unfrozen water content of the material, w_u. The unfrozen water content present in the materials at various temperatures, expressed in gravimetric form, w_{u-g}, had been determined in earlier characterization tests on the Mn/ROAD materials (Bigl and Berg

1996a). It is related to the temperature in the form

$$w_{u-g} = \alpha / 100 \ (-T / T_0)^\beta ; \quad T < 0°C \qquad (3)$$

where w_{u-g} = gravimetric unfrozen moisture content, in decimal form
T = temperature, °C
T_0 = 1.0°C
α and β = constants.

Table 5 presents the α and β constants characteristic of each material.

The first governing parameter we tried was w_{u-g}, expressed as a decimal, which had been normalized to the total gravimetric water content in the sample, w_t, also expressed as a decimal. The resulting equation was as follows:

$$M_r = K_1 (w_{u-g} / w_t)^{K_2} . \qquad (4)$$

This governing parameter has a good physical basis. When the material is very cold and solidly frozen, there is very little unfrozen water and the ratio w_{u-g}/w_t is a small number ($\ll 1$). When the material is just below the freezing point, w_{u-g}/w_t approaches a value of 1. However, when this form of the equation was used in the mechanistic design procedure (Bigl and Berg 1996b), the calculated amount of total water was often very high, and the ratio of unfrozen water to total water was unreasonably small. Therefore, other relationships were considered.

Table 5. Constants for unfrozen moisture content equations.

Soil	α	β
Subgrade		
1206	11.085	–0.274
1232	8.121	–0.303
Class 3		
Stockpile	1.497	–0.709
Class 4		
Taxiway A	3.0	–0.25*
Class 5		
Dense stone	2.0	–0.40*
Class 6		
Stockpile	0.567	–1.115

* Values for these materials are estimated

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The two other forms that were used to represent the unfrozen water content in the governing parameter of eq 1 were directly related to the unfrozen water content, as follows: 1) w_{u-g}, expressed as a decimal, normalized to a unit unfrozen water content, w_o, of 1.0; and 2) the volumetric unfrozen water content, w_{u-v}, expressed as a decimal, normalized to a unit unfrozen water content, w_o, of 1.0. The volumetric unfrozen water content was determined with

$$w_{u-v} = w_{u-g}\, \gamma_d \qquad (5)$$

where γ_d = dry density (Mg/m^3). The resulting equations with these terms substituted as the governing parameter were:

$$M_r = K_1 \left(w_{u-g} / w_o\right)^{K_2}$$

$$M_r = K_1 \left(w_{u-v} / w_o\right)^{K_2}.$$

In analyzing the frozen resilient modulus data, the value of the governing parameter w_{u-g} / w_t, w_{u-g} / w_o, or w_{u-v} / w_o at each test point was determined from the temperature (and total water content, if necessary.) Then, regression analysis was conducted to determine the relationship between these values and the measured resilient modulus. Data from the thawed, undrained state (assigned to be at a temperature just barely below freezing) were analyzed along with the frozen data.

Thawed/never frozen

For the never frozen and thawed data, the governing parameter in the general form equation (eq 1) was set to be a stress function. The constant K_1 was considered to be a function of the moisture level expressed as the degree of saturation in the sample and, when a range of data were available, the dry density. Thus, the general equation becomes

$$M_r = K_1 [f(\sigma)]^{K_2}, \qquad (6)$$

which includes the term

$$K_1 = C_0 (S / S_0)^{C_1} \qquad (7)$$

or

$$K_1 = C_0 (S / S_0)^{C_1} (\gamma_d / \gamma_o)^{C_2} \qquad (8)$$

where $f(\sigma)$ is a stress parameter normalized to a

unit stress of 6.9 kPa (1.0 lb/in.^{2}); C_0, C_1, and C_2 are constants; S is the degree of saturation, in %; S_0 is a unit saturation, 1.0%; γ_d is dry density, in Mg/m^3; and γ_o is a unit density (1.0 Mg/m^3). To conduct the regression analysis, we linearized this equation to form

$$\ln M_r = A_0 + A_1 \ln\left(S / S_0\right)$$

$$+ A_2 \ln\left(\gamma_d / \gamma_o\right) + A_3 \ln\left[f(\sigma)\right]. \qquad (9)$$

For a particular set of conditions, then,

$$K_1 = e^{A_0} \left(S / S_0\right)^{A_1} \left(\lambda_d / \gamma_o\right)^{A_2} \text{ and } K_2 = A_3.$$

Three stress parameters were investigated to help characterize the stress dependence of the materials tested. These included J_1, the bulk stress (or first stress invariant); τ_{oct}, the octahedral shear stress; and J_2/τ_{oct}, the ratio of the second stress invariant to the octahedral shear stress. In our repeated-load triaxial test, where $\sigma_2 = \sigma_3$ and $\sigma_1 = \sigma_3 + \sigma_d$, the functions are given as:

$$J_1 = 3\sigma_3 + \sigma_d$$

$$\tau_{oct} = \frac{\sqrt{2}}{3} \sigma_d$$

and

$$J_2 / \tau_{oct} = \frac{9\sigma_3^2 + 6\sigma_3\sigma_d}{\sqrt{2}\sigma_d}$$

where $J_1 = \sigma_1 + \sigma_2 + \sigma_3$

$$J_2 = \sigma_1\sigma_2 + \sigma_2\sigma_3 + \sigma_1\sigma_3$$

$$\tau_{oct} = \tfrac{1}{2}\sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2(\sigma_1 - \sigma_3)^2}.$$

We found that the bulk stress parameter (J_1) provided the best fit to the data for the class 6 special base material. The ratio J_2/τ_{oct} was the stress parameter that best fit the data of the three subbases class 3 special, class 4 special, and class 5 special, and τ_{oct} best characterized the clay subgrades.

We also analyzed the data from the class 6 special base material in the thawed condition using an equation of the form

$$M_r = K_1 e^{K_2 [f(\sigma)]}. \qquad (10)$$

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As before, K_1 was considered to be a function of the degree of saturation and the dry density (eq 8). In this case, the stress parameter, $f(\sigma)$, was the normalized bulk stress, J_1. This form of the equation was able to accommodate negative stress values that were generated in the layered elastic analysis portion of the predictive model.

RESULTS

General

Appendices A and B give a tabulation of all the laboratory test results of the frozen, thawed, and never-frozen soil specimens. Appendix A contains the data from the current study, which includes the two Mn/ROAD subgrade samples 1206 and 1232, the class 6 special base, and the class 3 special subbase. Appendix B contains the data determined previously from dense graded stone, the substitute for Mn/DOT's class 5 special subbase, and from Albany, New York, taxiway A subbase, the substitute for class 4 special subbase.

Data for the never-frozen 1206 subgrade specimens were acquired on a different testing machine than all the other data. After testing of all specimens was completed, we discovered that this second machine was out of calibration, such that the moduli reported here are much higher than they should be. However, data from the low density (CE 5) samples are close to moduli back-calculated from falling weight deflectometer (FWD) tests on subgrade at the site during fall of 1991.*

Table 6 summarizes the equations that resulted from the regression analysis performed on the data, with the frozen and unfrozen equations given in separate sections. The number "n" in Table 6 refers to the number of points evaluated in the analysis. Each stress combination at a given moisture level or temperature results in one data point; thus, the test of a single specimen results in many data points. The table also lists the coefficients of determination (r^2) for these analyses.

Frozen

Figures 4a through 4f illustrate the resilient modulus data vs. temperature for each material in

the frozen state. Also shown are the data for the thawed, undrained condition, which are assumed to be valid at a temperature of 0°C and were included as the warmest data point of the regression analyses. Superimposed on the data are lines showing the moduli predicted by the three types of regression equations. Where the predictive equation requires normalization to the total water content, that parameter was set to be the average value for all the specimens tested. For the predictive equation with volumetric unfrozen water, the dry density was also set to be the average value for all the specimens tested.

Figure 4 shows that the frozen modulus does vary primarily as a function of the unfrozen water content. A minor amount of variation results from the various stress combinations acting on the specimens, as shown from the vertical spread in the data at any particular temperature. To illustrate this, Figure 5 shows the data from a few individual deviator stress levels plotted separately for the subgrade samples.

All three types of predictive equations appear to represent the data fairly well. The moduli resulting from the governing parameter, normalized to the total water content, increases less rapidly with decreasing temperature at temperatures just below freezing than do moduli from the other two equations. Unfortunately, the temperature variation of the environmental chamber of the testing machine was too great to allow acquisition of data at temperatures close to the freezing point for the Mn/ROAD materials. When the two substitute materials were tested, a different chamber temperature controlling system was used, and it was possible to obtain data nearer to the freezing point. In these cases, shown in Figures 4d and 4e, the predictive equations without normalization to total water appear to pass nearer to the center of the range of data collected at temperatures warmer than –2.0°C.

Figure 4 also shows that the predictions from the equations whose governing parameters are the gravimetric and volumetric unfrozen water normalized to a unit unfrozen water are not very different. Predictions from the volumetric form rise less rapidly at temperatures just below freezing, while at the colder temperatures, they are slightly larger than the gravimetric form.

*D. Van Deusen, Mn/ROAD, pers. comm. 1992.
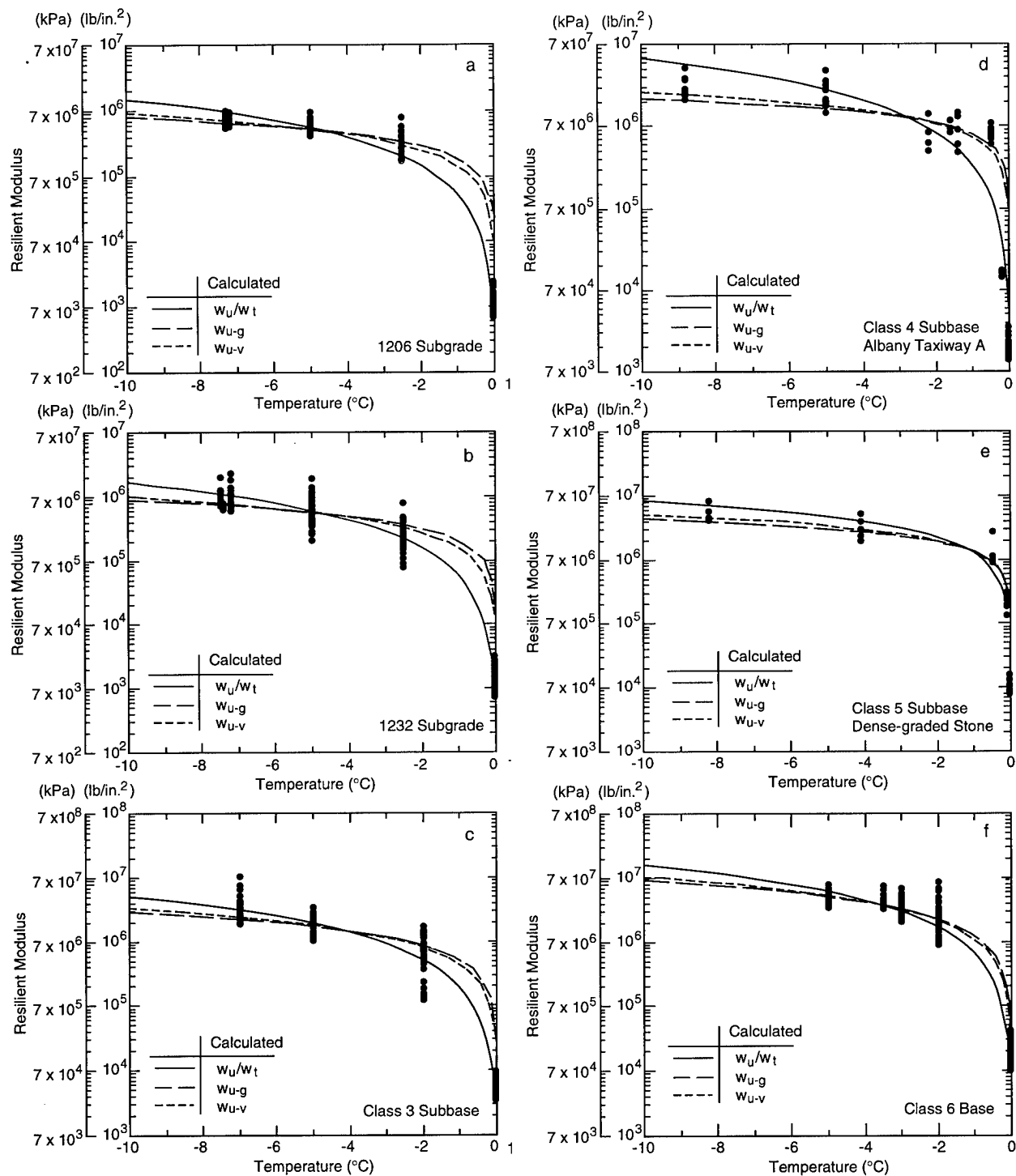
Figure 4. Frozen resilient modulus data vs. temperature. Calculated lines are based on mean total water content or density of all specimens tested, where appropriate.

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Table 6. Results of regression analyses—test soils from Mn/ROAD.

A. Frozen condition.

Material	Equation (M_r in lb/in.^{2})*	n	r^2	Std error
Clay subgrade sample 1206 (565)				
Frozen	$M_r = 1,087 f(w_u)^{-5.259}$	207	0.99	0.319
Frozen	$M_r = 1,049 f(w_{u-g})^{-2.344}$	207	0.99	0.275
Frozen	$M_r = 1,052 f(w_{u-v})^{-2.929}$	207	0.99	0.262
Clay subgrade sample 1232 (566)				
Frozen	$M_r = 905 f(w_u)^{-4.821}$	244	0.98	0.378
Frozen	$M_r = 846 f(w_{u-g})^{-2.161}$	244	0.98	0.423
Frozen	$M_r = 848 f(w_{u-v})^{-2.633}$	244	0.98	0.394
Class 3 "stockpile"				
Frozen	$M_r = 5,824 f(w_u)^{-2.026}$	186	0.97	0.491
Frozen	$M_r = 5,488 f(w_{u-g})^{-1.076}$	210	0.97	0.507
Frozen	$M_r = 5,542 f(w_{u-v})^{-1.249}$	186	0.97	0.467
Class 4 (taxiway A subbase)				
Frozen	$M_r = 2,826 f(w_u)^{-5.220}$	69	0.92	0.835
Frozen	$M_r = 1,813 f(w_{u-g})^{-1.733}$	85	0.93	0.885
Frozen	$M_r = 1,652 f(w_{u-v})^{-2.813}$	69	0.91	0.916
Class 5 (dense graded stone)				
Frozen	$M_r = 11,320 f(w_u)^{-2.036}$	28	0.97	0.404
Frozen	$M_r = 8,695 f(w_{u-g})^{-1.2814}$	28	0.95	0.511
Frozen	$M_r = 9,245 f(w_{u-v})^{-1.489}$	28	0.97	0.432
Class 6 "stockpile"				
Frozen	$M_r = 19,924 f(w_u)^{-1.243}$	260	0.98	0.372
Frozen	$M_r = 19,427 f(w_{u-g})^{-0.795}$	260	0.98	0.338
Frozen	$M_r = 19,505 f(w_{u-v})^{-0.897}$	260	0.98	0.341

Notes: n = number of test points
r^2 = coefficient of determination
M_r = resilient modulus
$f(S) = S/S_o$
   S = degree of saturation (%)
   S_o = 1.0 %
$f(\gamma) = \gamma_d/\gamma_o$
   γ_d = dry density (Mg/m^3)
   γ_o = 1.0 Mg/m^3
$f(w_u) = w_{u-g}/w_t$
   w_{u-g} = gravimetric unfrozen water content
   w_t = gravimetric total water content
$f(w_{u-g}) = w_{u-g}/w_o$
   w_o = unit water content (1.0)

$f(w_{u-v}) = w_{u-v}/w_o$
w_{u-v} = volumetric unfrozen
       water content
σ = stress (lb/in.^{2})
$f_1(\sigma) = J_1/\sigma_o$
$f_2(\sigma) = (J_2/\tau_{oct})/\sigma_o$
$f_3(\sigma) = \tau_{oct}/\sigma_o$
σ_o = 1.0 lb/in.^{2}
J_1 = bulk stress (lb/in.^{2})
$J_1 = 3\sigma_3 + \sigma_d$
J_2 = 2nd stress invariant (lb/in.^{2})
$J_2 = 3\sigma_3^2 + 2\sigma_3\sigma_d$
τ_{oct} = octahedral shear stress (lb/in.^{2})
$\tau_{oct} = (\sqrt{2}/3)\sigma_d$

*Output from equations can be converted to kilopascals through multiplying by 6.895

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Table 6 (cont'd). Results of regression analyses—test soils from Mn/ROAD.

B. Unfrozen condtion

Material	Equation (M_r in lb/in.^{2})*	n	r^2	Std error
Clay subgrade sample 1206 (565)				
Never frozen	$M_r = 1,597,000 f(S)^{-2.63} f(\gamma)^{14.42} f_3(\sigma)^{-0.257}$	655	0.82	0.251
Clay subgrade sample 1232 (566)				
Never frozen	$M_r = 1.518 \times 10^{30} f(S)^{-13.85} f_3(\sigma)^{-0.272}$	451	0.95	0.328
Class 3 "stockpile"				
Thawed	$M_r = 283,300 f(S)^{-1.003} f_2(\sigma)^{0.206}$	408	0.86	0.520
Class 4 (taxiway A subbase)				
Thawed	$M_r = 8.946 \times 10^8 f(S)^{-3.026} f_2(\sigma)^{0.292}$	149	0.86	0.168
Class 5 (dense graded stone)				
Thawed	$M_r = 382,400 f(S)^{-0.8759} f_2(\sigma)^{0.1640}$	64	0.77	0.164
Class 6 "stockpile"				
Thawed	$M_r = 1,391 f(S)^{-0.507} f(\gamma)^{4.04} f_1(\sigma)^{0.608}$	492	0.79	0.232
Thawed	$M_r = 5,257 f(S)^{-0.486} f(\gamma)^{4.05} e^{0.0193 f_1(\sigma)}$	492	0.76	0.249

*Output from equations can be converted to kilopascals through multiplying by 6.895
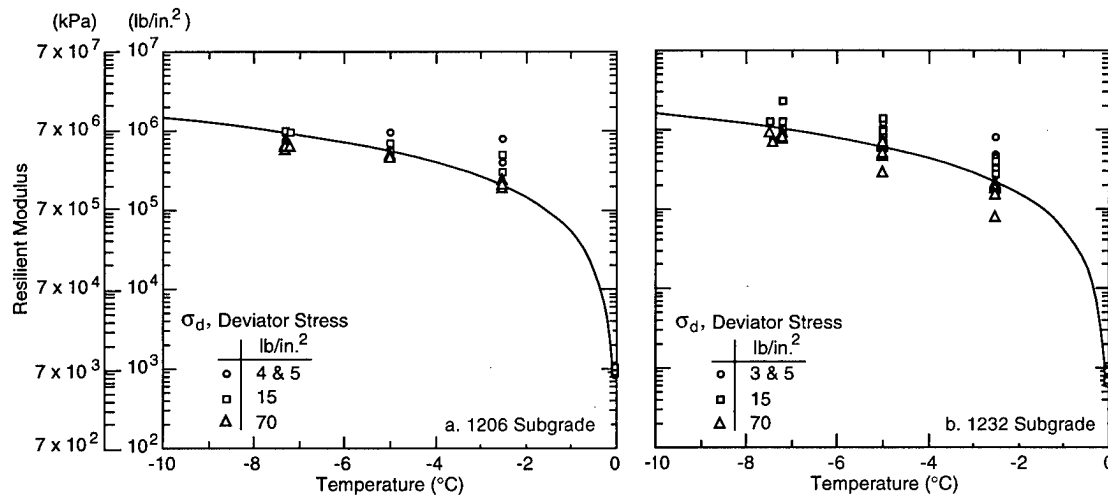
Figure 5. Effect of stress on frozen resilient modulus.

Figure 6 compares the modulus vs. temperature for all the frozen Mn/DOT materials predicted from the regression equations in Table 6, with the governing parameters w_{u-g}/w_t and w_{u-v}. At any given temperature, the subgrade specimens have the lowest moduli. In general, the base and subbase moduli increase with decreasing amounts of fines in the material. The curve for the class 5 special material has a slightly different shape than the rest, which is probably related to the estimated choice of coefficients for the distribution of unfrozen water content with temperature.

Unfrozen

Figures 7a through 7f show the resilient modulus data vs. degree of saturation for the unfrozen specimens. For the two subgrade materials, data are from specimens that were never frozen, and data from the base/subbase materials are from specimens that were thawed subsequent to freez-

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ing. Also shown is a line representing the predicted moduli resulting from the equations given in Table 6, at the mean stress level tested. Where dry density is included in the equation, it was set at the average value of all specimens tested. It can be seen in Figures 7a through 7f that moisture level does influence the unfrozen moduli, but to different degrees, depending on the material.

The vertical spread in the data points at a particular degree of saturation (Fig. 7) is the result of the materials response to the different stress combinations applied (Table 3a). In the case of the 1206 subgrade and the class 6 special base, it also relates to the variation in density. To show the influence of density in the 1206 subgrade data, Figure 8 differentiates the data from three density ranges (high, medium, and low), along with the corresponding predicted resilient moduli lines. Note that the low density moduli are most representative of moduli back-calculated from FWD deflections measured on site at Mn/ROAD.
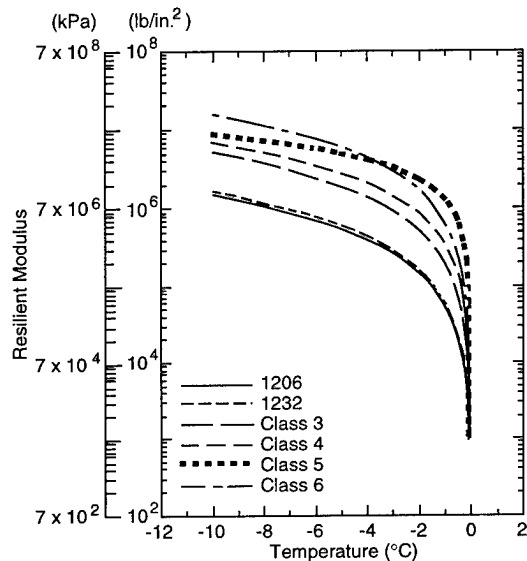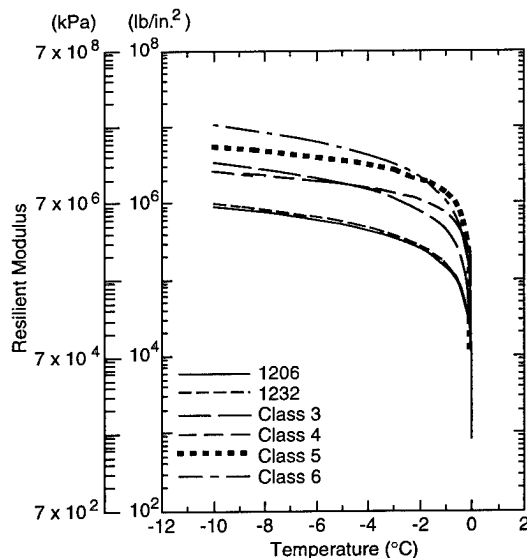
The effect of stress combinations is shown in Figure 9 for the low-density 1206 subgrade data, and all of the 1232 subgrade and class 3 special subbase data. The two subgrades display an inverse relationship between modulus and deviator stress; the class 3 special subbase has a proportional relationship between modulus and the stress parameter J_2/τ_{oct}.

Figure 10 demonstrates the relative influence of the deviator stress and confining pressure (σ_3) on the modulus of a single 1206 subgrade specimen at 16.1% water content. The deviator stress has the major influence, while confining pressure produces only minor variations in the moduli. The figure also includes a line of predicted resilient moduli based on a regression analysis of these data alone, in the form:

$$M_r \ (lb/ft^2) = K_1 \ (\sigma_d)^{K_2},$$

as well as the upper and lower 95% confidence interval around the mean line. The confidence band brackets the variation in modulus related to σ_3.

We generated several predicted curves for individual samples as described above to isolate the influence of moisture content and density, respectively, on the resilient modulus of the 1206 subgrade material. Figure 11 shows the relationship between modulus and deviator stress of specimens with a similar density, but with different moisture levels. It confirms the expected relationship that the drier sample exhibits a higher modulus at similar stress conditions. Figure 12 compares two samples with similar moisture, showing that the higher density sample has higher moduli.

A comparison of the predicted modulus curves generated by the equations in Table 6 for all the materials studied is given in Figure 13. Among the curves of the base/subbase materials, there is a general increase in the predicted moduli as the

a. Governing parameter w_{u-g}/w_t.

b. Governing parameter w_{u-v}.

Figure 6. Predicted frozen resilient modulus for all Mn/ROAD materials.

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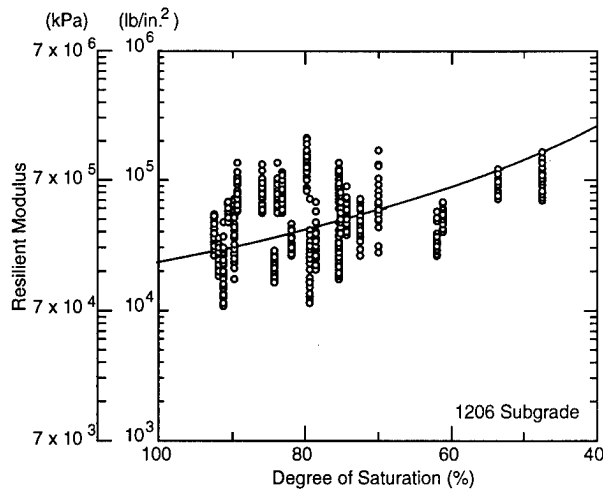
a. 1206 subgrade. (These data are probably in error— see text.)

b. 1232 subgrade.
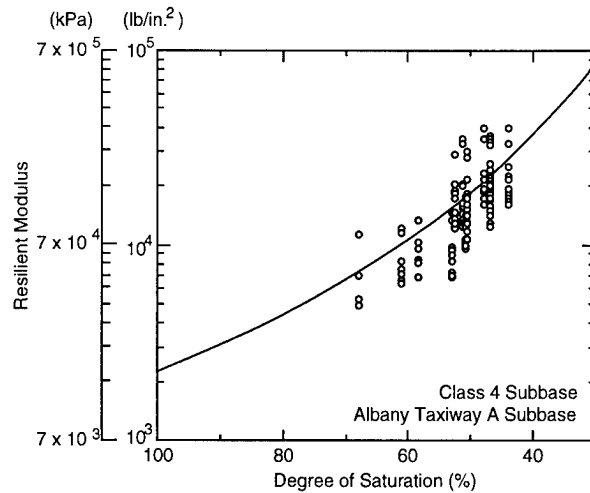
c. Class 3 special subbase.
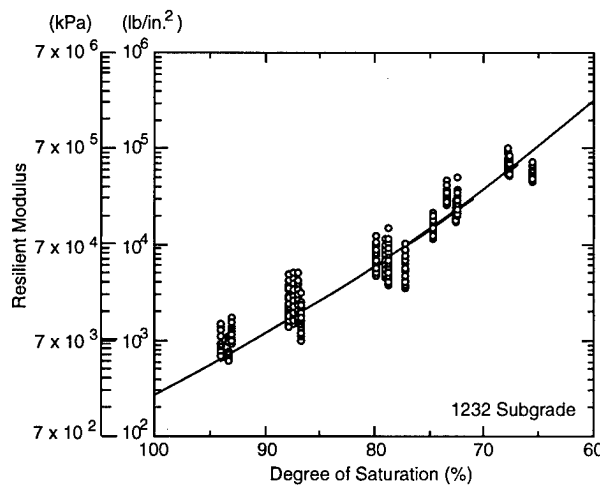
d. Class 4 special subbase.
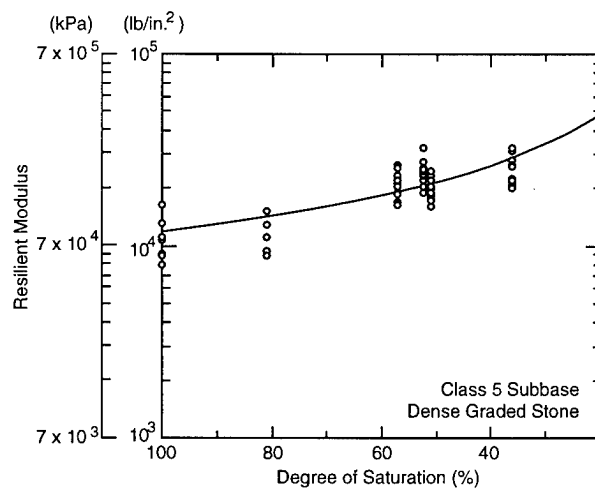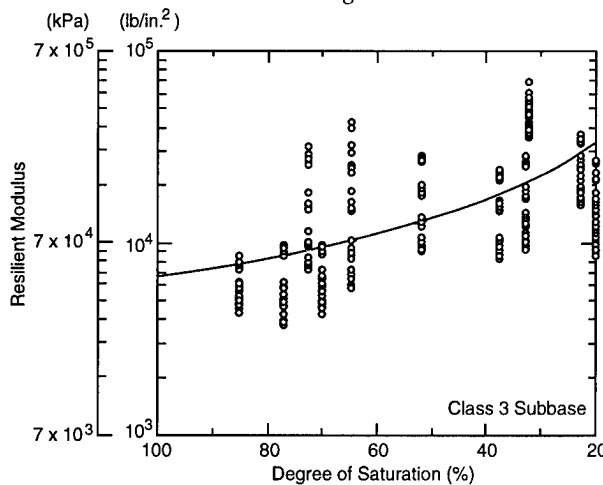
e. Class 5 special subbase.
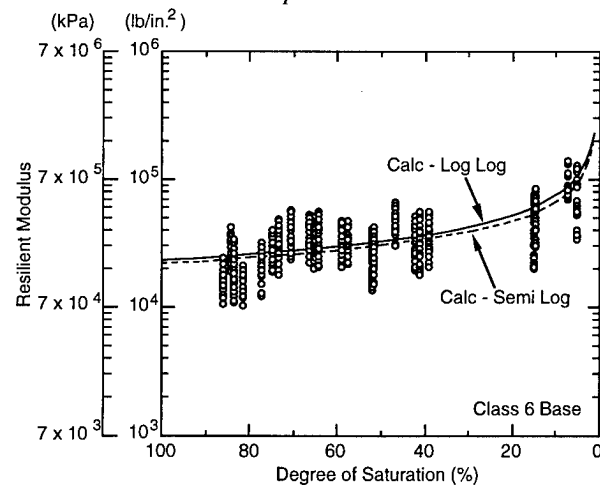
f. Class 6 special base.

Figure 7. Resilient modulus vs. degree of saturation for never frozen subgrade materials and thawed base/ subbase materials. Solid line represents calculated value based on mean condition of stress (and density where included).

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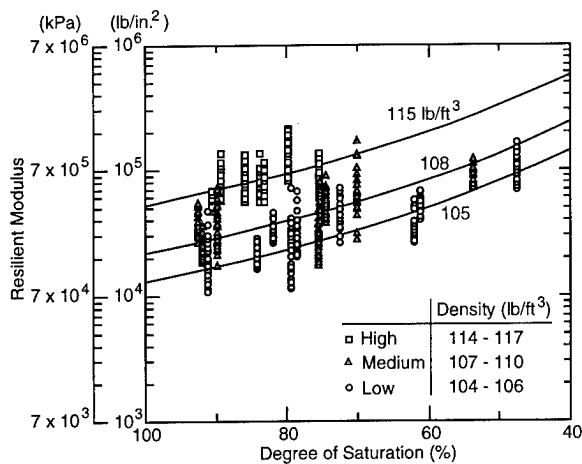
Figure 8. Resilient modulus vs. degree of saturation of never-frozen 1206 subgrade material illustrating the effect of dry density.

a. Low-density (1.66–1.7-Mg/m³ or 104–106-lb/ft³) 1206 subgrade. (These data are probably in error—see text.)

b. 1232 subgrade.

c. Class 3 special subbase.

Figure 9. Resilient modulus vs. degree of saturation illustrating effect of stress parameters.

amount of fines in the material decreases, with the exception of the class 4 special material. There is also a decrease in the slope of the predicted curves with decreasing fine content, indicating the expected lesser influence of moisture content on the moduli of the coarser materials. The curves of the two clay subgrades depart somewhat from this pattern. The curve for the 1232 subgrade has an extremely steep slope, showing a much stronger influence of the degree of saturation on the modulus. The curve of predicted moduli for the 1206 subgrade is higher than those for the coarser materials. Although this is contrary to conventional rules-of-thumb, high moduli for cohesive materials have also been reported by Robnet and Thompson (1973). However, it is more likely that the high 1206 subgrade moduli are related to the miscalibration of the testing machine. This possibility is being investigated in more detail and findings will be included in the Phase 2 report (Berg in prep.).

For each material tested, Figure 14 shows the frozen and thawed/unfrozen moduli data points and curves based on the regression equations resulting from this analysis. Data in Figure 14 illustrate the rapid increase in modulus as the soils freeze and a lower-magnitude increase in modulus values with decreasing saturation. To illustrate these general trends, the calculated relationships vs. degree of saturation are also shown, for one stress condition only. As shown in Figure 9, stress conditions also influence resilient modulus values.

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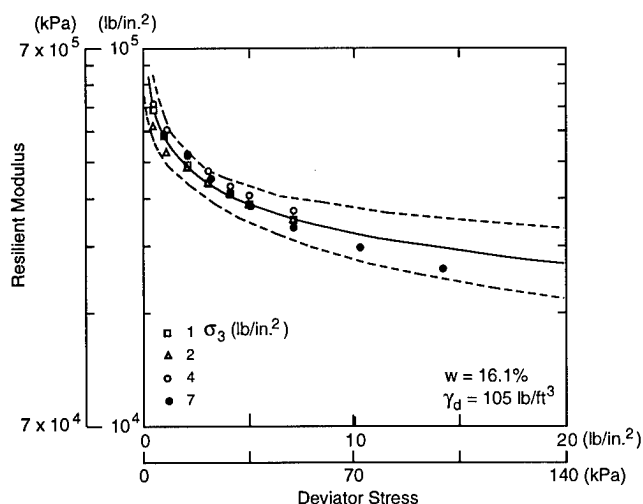
Figure 10. Resilient modulus vs. deviator stress applied to a single 1206 subgrade specimen. Data points illustrate level of confining stress applied. Dashed lines indicate band of 95% confidence interval.
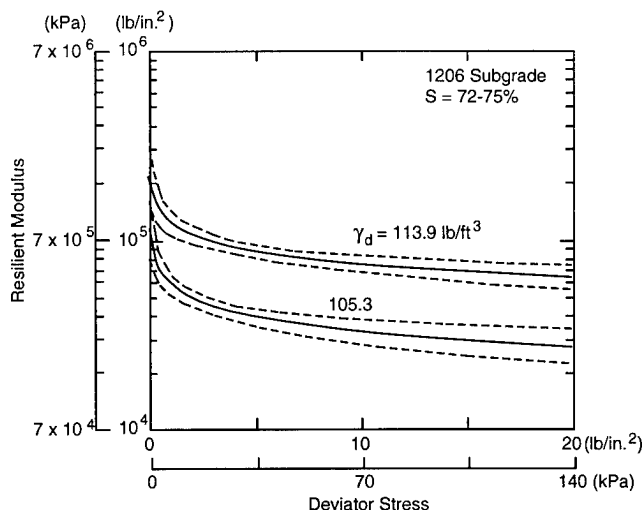
Figure 12. Resilient modulus vs. deviator stress applied to two 1206 subgrade specimens illustrating effect of dry density. Dashed lines indicate band of 95% confidence interval.
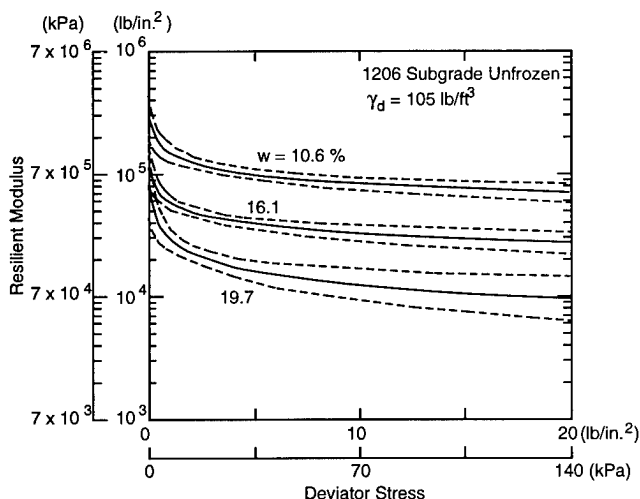
Figure 11. Resilient modulus vs. deviator stress applied to three 1206 subgrade specimens illustrating effect of moisture condition. Dashed lines indicate band of 95% confidence interval.
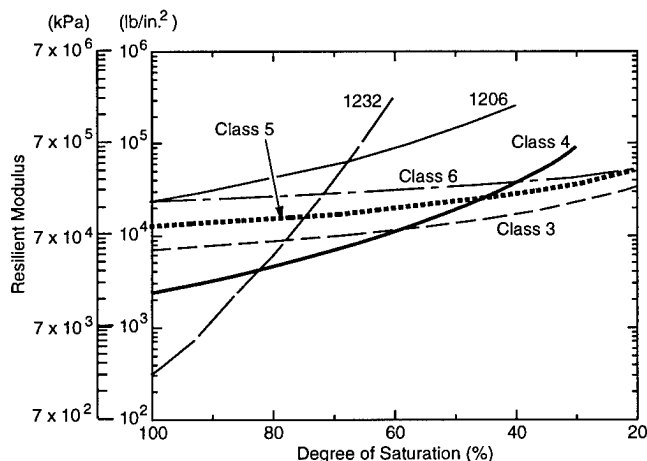
Figure 13. Predicted moduli for all materials in unfrozen condition.

A significant discontinuity between thawed 0°C and 100% saturated modulus values is shown in Figure 14a. As indicated previously, the difference is probably due to miscalibration of the testing equipment for the unfrozen data rather than an actual large difference in resilient modulus values at these points. These data are currently being reexamined and findings will be reported in the Phase 2 report (Berg in prep.).

For the granular base and subbase materials, essentially no discontinuity is apparent between the modulus of the thawed, 0°C material and the same material at 100% saturation.

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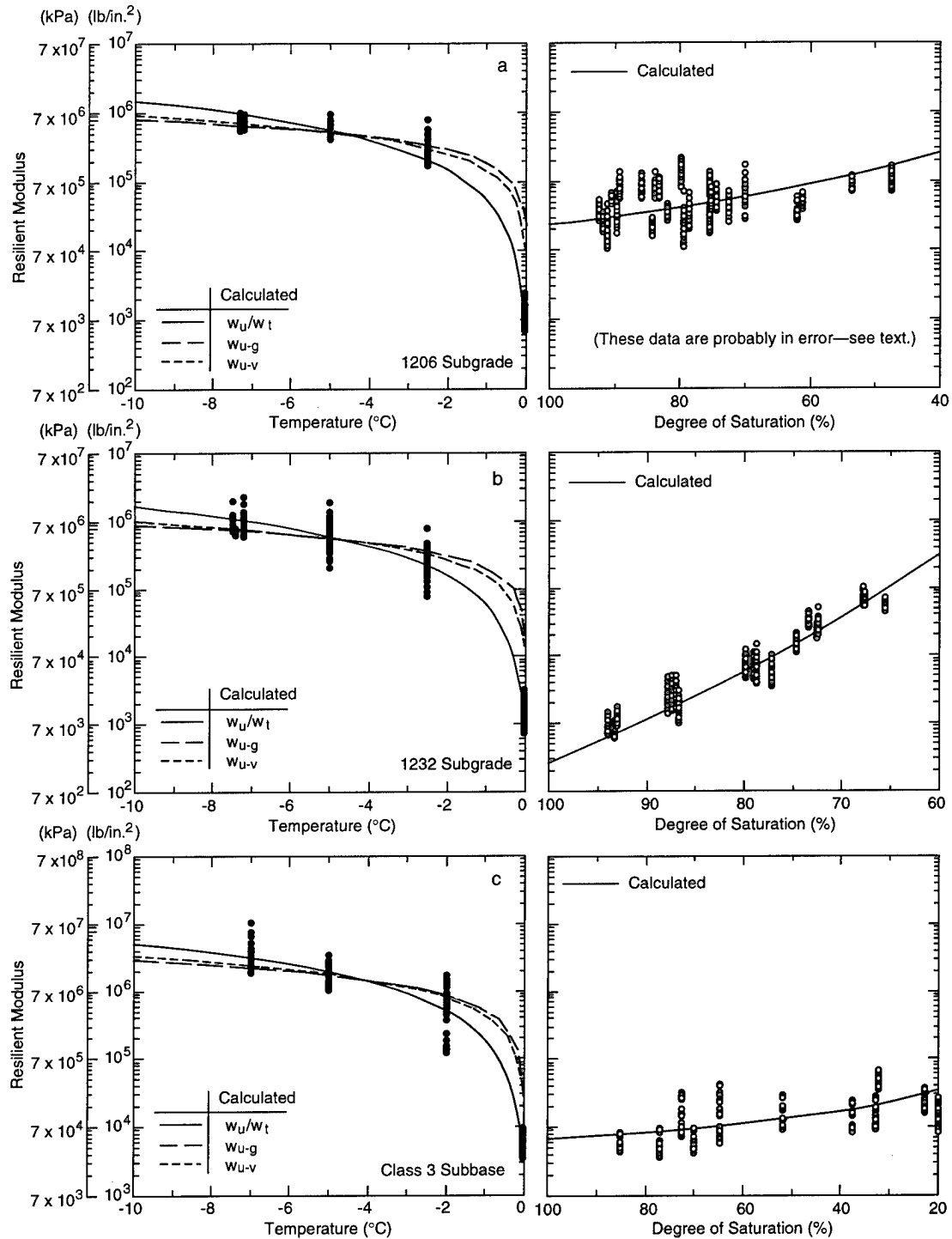
Figure 14. Comparison of frozen and unfrozen modulus data.

Figure 14 (cont'd).

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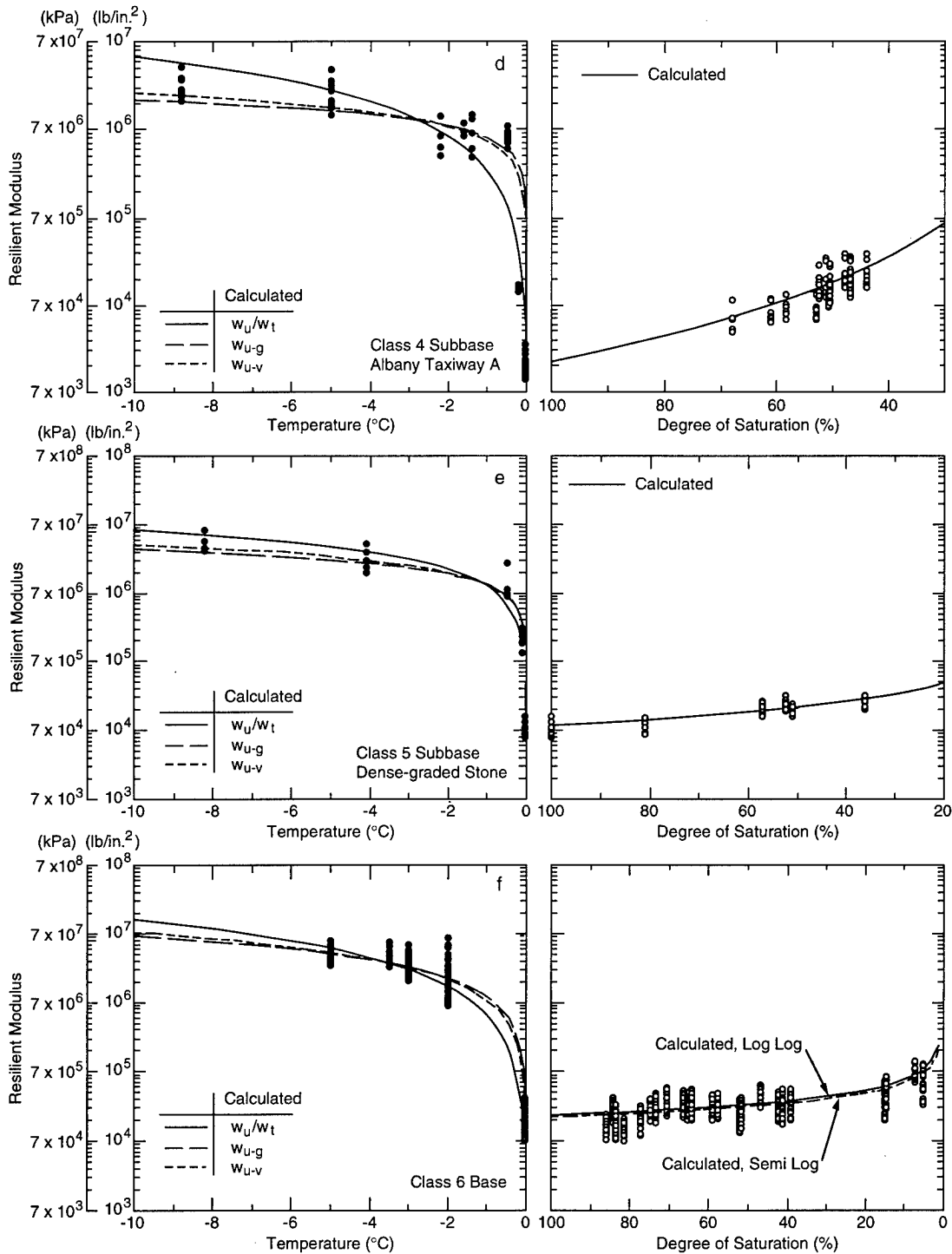
CONCLUSIONS

Laboratory resilient modulus tests on the Mn/ROAD unbound base and subgrade materials have resulted in the following:

1. All materials exhibited a two to three order of magnitude increase in resilient modulus at subfreezing temperatures of $-2°C$ and lower.
2. All of the materials exhibited an increase in modulus as the degree of saturation decreased.
3. The modulus value of all of the materials was stress dependent.
4. For the highly frost-susceptible 1206 subgrade and the class 6 special base course, the resilient modulus was also dependent on the density of the sample tested. We did not test samples at a wide variety of densities for the other materials, but density probably impacts modulus values of those materials also.

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1206 SUBGRADE

Frozen

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M5-1A	106.5	22.6	27.5	10.0	5.2	0.131	395,600
					10.4	0.305	339,100
					15.1	0.520	291,000
					19.9	0.781	255,100
					30.3	1.302	232,500
					39.8	1.824	218,400
					51.0	2.522	202,200
					70.1	3.790	184,900
					90.0	5.017	179,400
			23.0	10.0	10.4	0.141	733,900
					15.1	0.250	606,200
					19.9	0.369	539,600
					30.3	0.564	536,300
					39.8	0.760	524,200
					51.0	0.999	510,500
					70.1	1.474	475,700
					89.2	1.951	457,200
					119.5	2.822	423,400
			18.9	10.0	5.2	0.069	746,500
					10.4	0.147	702,600
					15.1	0.217	698,600
					19.9	0.292	680,900
					30.3	0.455	665,400
					39.8	0.693	574,500
					51.0	0.910	560,300
					70.1	1.257	557,800
					89.2	1.603	556,400
					121.1	2.254	537,100
M5-1B	104.1	24.1	27.5	10.0	5.2	0.065	794,900
					10.4	0.185	561,100
					15.2	0.303	500,000
					20.0	0.477	418,600
					30.3	0.867	349,900
					39.9	1.258	317,300
					51.1	1.822	280,300
					70.2	2.911	241,300
					89.4	4.134	216,300
			23.0	10.0	5.2	0.054	956,400
					10.4	0.130	797,000
					15.2	0.217	700,100
					20.0	0.303	658,000
					30.3	0.487	622,300
					39.9	0.693	575,700
					51.1	1.105	462,300
					70.2	1.560	450,200
					89.4	2.038	438,700
					118.1	2.778	425,300

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M5-1B	104.1	24.1	18.9	10.0	15.2	0.152	998,400
					20.0	0.228	875,700
					30.3	0.380	798,700
					39.9	0.543	735,600
					51.1	0.738	692,300
					70.2	1.107	634,600
					89.4	1.476	605,700
					121.3	2.171	558,800
M5-2A	104.6	23.4	27.5	10.0	5.2	0.131	395,200
					10.3	0.305	338,700
					15.1	0.498	303,100
					19.9	0.694	286,500
					30.2	1.150	262,800
					39.8	1.649	241,000
					50.9	2.260	225,100
					70.8	3.483	203,200
					89.0	4.795	185,700
			23.0	10.0	5.2	0.087	596,300
					10.3	0.173	596,300
					15.1	0.238	633,900
					19.9	0.325	611,600
					30.2	0.542	557,800
					39.8	0.737	539,600
					50.9	0.997	510,500
					70.0	1.387	504,400
					89.0	1.865	477,500
					111.3	2.603	427,500
			18.9	10.0	10.3	0.108	953,400
					15.1	0.163	929,000
					19.9	0.230	864,900
					30.2	0.390	774,700
					39.8	0.520	764,000
					50.9	0.759	670,500
					70.0	1.083	645,800
					89.0	1.409	632,100
					120.8	2.255	536,000
M5-2B	106.0	22.8	27.5	10.0	5.2	0.109	475,800
					10.4	0.305	339,900
					15.2	0.520	291,300
					19.9	0.737	270,600
					30.3	1.258	240,900
					39.9	1.757	226,900
					51.0	2.388	213,700
					70.2	3.782	185,500
					89.3	5.229	170,800
			23.0	10.0	5.2	0.087	594,800
					10.4	0.185	559,800

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M5-2B	106.0	22.8	23.0	10.0	15.2	0.283	535,000
					19.9	0.381	522,900
					30.3	0.588	515,100
					39.9	0.784	508,300
					51.0	1.046	487,900
					70.2	1.482	473,400
					89.3	2.006	445,200
					111.6	2.706	412,600
			19.0	10.0	10.4	0.108	956,600
					15.2	0.163	932,100
					19.9	0.217	920,200
					30.3	0.347	874,200
					39.9	0.542	736,200
					51.0	0.737	692,800
					70.2	1.127	622,800
					89.3	1.473	606,100
					121.2	2.124	570,700
M3-1	0.0	0.0	27.5	10.0	5.2	0.108	477,100
					10.3	0.282	367,000
					15.1	0.477	316,600
					19.9	0.759	261,800
					29.8	1.390	214,500
					38.2	2.173	175,600
					49.3	2.828	174,300
					70.0	4.794	145,900
			23.0	10.0	10.3	0.325	318,000
					15.1	0.477	316,900
					20.7	0.693	298,200
					29.4	0.953	308,600
					40.5	1.387	292,400
					49.3	1.474	334,500
					70.0	2.168	322,800
					89.0	2.819	315,900
M3-2	0.0	0.0	27.5	10.0	5.2	0.087	597,500
					10.4	0.173	597,500
					15.1	0.260	582,100
					19.9	0.564	353,300
					30.3	1.519	199,300
					38.2	2.823	135,400
					49.4	3.697	133,600
			23.0	10.0	10.4	0.173	597,500
					15.1	0.260	582,200
					19.9	0.368	540,700
					30.3	0.607	499,000
					39.8	0.888	448,300
					51.0	1.214	420,100
					70.1	1.951	359,300

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M3-2	0.0	0.0	23.0	10.0	89.2	2.689	331,800
			19.4	10.0	10.4	0.141	735,400
					14.7	0.217	680,300
					19.9	0.303	656,600
					30.3	0.498	607,500
					39.8	0.672	593,100
					48.6	0.823	590,300
					69.3	1.257	551,500
					89.2	1.690	527,900
					119.5	2.492	479,500
M3-3	0.0	0.0	27.5	10.0	5.2	0.087	594,600
					10.3	0.227	453,000
					15.1	0.390	386,200
					19.8	0.650	304,800
					29.7	1.214	244,900
					39.6	1.821	217,600
					50.7	2.690	188,600
					69.8	4.431	157,400
			23.0	10.0	10.3	0.141	731,800
					15.1	0.260	579,300
					20.2	0.368	548,800
					30.1	0.585	514,900
					39.6	0.845	469,000
					49.1	1.127	436,200
					69.8	1.777	392,500
					88.8	2.384	372,300
			19.4	10.0	10.3	0.065	1,585,500
					15.1	0.108	1,390,400
					19.8	0.217	914,700
					30.1	0.368	817,900
					39.6	0.607	653,400
					50.7	0.834	608,200
					69.8	1.343	519,300
					90.4	1.907	473,900
					120.5	2.818	427,600
M3-4	0.0	0.0	27.5	10.0	5.2	0.173	298,200
					10.3	0.368	280,600
					15.1	0.607	248,900
					19.9	0.802	247,800
					30.2	1.258	240,200
					39.8	1.736	229,000
					50.9	2.389	213,000
					70.0	3.696	189,300
			23.0	10.0	15.1	0.238	633,900
					19.1	0.303	629,100
					29.4	0.542	543,100
					40.5	0.823	492,500

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M3-4	0.0	0.0	23.0	10.0	50.5	1.040	485,400
					70.0	1.604	436,200
					89.0	2.168	410,700
			19.4	10.0	10.3	0.087	1,192,700
					15.1	0.130	1,162,100
					20.7	0.184	1,122,500
					30.2	0.325	929,700
					40.5	0.455	891,200
					50.1	0.585	856,300
					70.0	0.888	787,700
					89.0	1.170	761,100
					119.3	1.863	640,000

1206 SUBGRADE

Unfrozen

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Compactive Effort CE5								
1206-18A	110.3	13.7	7.0	14.1	0.753	5.002	0.151	28,200
				10.3	0.669	3.251	0.206	31,500
				7.0	0.335	1.625	0.206	43,400
				5.0	0.293	0.925	0.316	54,000
				4.1	0.251	0.700	0.358	58,600
				3.1	0.167	0.475	0.352	64,700
				2.1	0.084	0.250	0.334	82,000
				1.0	0.042	0.100	0.418	102,500
			4.0	7.0	0.334	1.450	0.231	48,600
				5.0	0.251	0.900	0.279	55,500
				4.1	0.209	0.675	0.310	60,700
				3.1	0.167	0.450	0.372	68,300
				2.0	0.084	0.250	0.334	81,900
				1.0	0.042	0.100	0.418	102,400
				0.5	0.000	0.040	0.000	129,600
			2.0	7.0	0.334	1.400	0.239	50,300
				5.0	0.251	0.850	0.295	58,700
				4.1	0.209	0.625	0.334	65,500
				3.1	0.167	0.400	0.418	76,800
				2.0	0.125	0.200	0.627	102,400
				1.1	0.084	0.080	1.045	132,000
				0.5	0.000	0.030	0.000	170,600
			1.0	7.0	0.251	1.400	0.179	50,300
				5.0	0.167	0.825	0.203	60,500
				4.1	0.084	0.600	0.139	68,200
				3.1	0.042	0.400	0.104	76,800
				2.0	0.000	0.225	0.000	91,000
				1.0	0.000	0.100	0.000	102,300
				0.5	0.000	0.040	0.000	127,900
1206-18B	107.4	15.9	7.0	14.1	1.171	8.004	0.146	17,600
				10.3	0.837	5.603	0.149	18,300
				7.1	0.502	3.402	0.148	20,700
				5.0	0.335	2.201	0.152	22,700
				4.1	0.167	1.701	0.098	24,100
				3.1	0.000	1.151	0.000	26,700
				2.1	0.000	0.650	0.000	31,500
				1.0	0.000	0.275	0.000	38,000
			4.0	10.2	2.341	5.203	0.450	19,700
				7.0	1.003	3.252	0.309	21,700
				4.1	0.752	1.601	0.470	25,600
				3.1	0.502	1.101	0.456	27,900
				2.0	0.418	0.675	0.619	30,300
				1.0	0.167	0.300	0.557	34,100
				0.5	0.084	0.125	0.668	41,500

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Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Compactive Effort CE5								
1206-18A	110.3	13.7	7.0	14.1	0.753	5.002	0.151	28,200
				10.3	0.669	3.251	0.206	31,500
				7.0	0.335	1.625	0.206	43,400
				5.0	0.293	0.925	0.316	54,000
				4.1	0.251	0.700	0.358	58,600
				3.1	0.167	0.475	0.352	64,700
				2.1	0.084	0.250	0.334	82,000
				1.0	0.042	0.100	0.418	102,500
			4.0	7.0	0.334	1.450	0.231	48,600
				5.0	0.251	0.900	0.279	55,500
				4.1	0.209	0.675	0.310	60,700
				3.1	0.167	0.450	0.372	68,300
				2.0	0.084	0.250	0.334	81,900
				1.0	0.042	0.100	0.418	·102,400
				0.5	0.000	0.040	0.000	129,600
			2.0	7.0	0.334	1.400	0.239	50,300
				5.0	0.251	0.850	0.295	58,700
				4.1	0.209	0.625	0.334	65,500
				3.1	0.167	0.400	0.418	76,800
				2.0	0.125	0.200	0.627	102,400
				1.1	0.084	0.080	1.045	132,000
				0.5	0.000	0.030	0.000	170,600
			1.0	7.0	0.251	1.400	0.179	50,300
				5.0	0.167	0.825	0.203	60,500
				4.1	0.084	0.600	0.139	68,200
				3.1	0.042	0.400	0.104	76,800
				2.0	0.000	0.225	0.000	91,000
				1.0	0.000	0.100	0.000	102,300
				0.5	0.000	0.040	0.000	127,900
1206-18B	107.4	15.9	7.0	14.1	1.171	8.004	0.146	17,600
				10.3	0.837	5.603	0.149	18,300
				7.1	0.502	3.402	0.148	20,700
				5.0	0.335	2.201	0.152	22,700
				4.1	0.167	1.701	0.098	24,100
				3.1	0.000	1.151	0.000	26,700
				2.1	0.000	0.650	0.000	31,500
				1.0	0.000	0.275	0.000	38,000
			4.0	10.2	2.341	5.203	0.450	19,700
				7.0	1.003	3.252	0.309	21,700
				4.1	0.752	1.601	0.470	25,600
				3.1	0.502	1.101	0.456	27,900
				2.0	0.418	0.675	0.619	30,300
				1.0	0.167	0.300	0.557	34,100
				0.5	0.084	0.125	0.668	41,500

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-18B	107.4	15.9	2.0	7.0	0.836	2.402	0.348	29,300
				5.0	0.418	1.601	0.261	31,200
				4.1	0.251	1.276	0.196	32,100
				3.1	0.167	0.901	0.186	34,100
				2.0	0.125	0.550	0.228	37,200
				1.0	0.084	0.250	0.334	41,700
				0.5	0.000	0.113	0.000	47,200
			1.0	7.0	0.585	2.477	0.236	28,400
				5.0	0.334	1.701	0.196	29,700
				4.1	0.251	1.301	0.193	31,400
				3.1	0.209	0.926	0.226	33,100
				2.0	0.084	0.550	0.152	37,200
				1.0	0.042	0.250	0.167	40,900
				0.5	0.000	0.113	0.000	47,100
1206-18C	105.3	16.1	7.0	14.2	1.090	5.401	0.202	26,200
				10.3	0.755	3.451	0.219	29,800
				7.1	0.587	2.101	0.279	33,700
				5.1	0.335	1.350	0.248	38,100
				4.1	0.252	1.000	0.251	41,200
				3.2	0.168	0.700	0.239	45,000
				2.1	0.084	0.400	0.210	51,800
				1.0	0.042	0.175	0.239	58,800
			4.0	7.1	0.503	1.900	0.264	37,200
				5.0	0.251	1.225	0.205	40,900
				4.1	0.251	0.950	0.264	43,300
				3.1	0.168	0.650	0.258	47,400
				2.1	0.084	0.400	0.209	52,200
				1.1	0.042	0.175	0.239	60,600
				0.5	0.000	0.075	0.000	71,100
			2.0	7.1	0.419	2.000	0.209	35,300
				5.0	0.335	1.300	0.258	38,500
				4.1	0.251	1.000	0.251	41,100
				3.1	0.167	0.700	0.239	44,000
				2.1	0.126	0.425	0.295	48,300
				1.1	0.000	0.200	0.000	52,900
				0.5	0.000	0.088	0.000	61,600
			1.0	7.1	0.418	2.000	0.209	35,300
				5.0	0.335	1.300	0.257	38,500
				4.1	0.251	1.000	0.251	41,000
				3.1	0.167	0.700	0.239	44,000
				2.1	0.084	0.425	0.197	49,000
				1.0	0.000	0.175	0.000	58,600
				0.5	0.000	0.075	0.000	68,400
1206-21B	106.4	19.7	7.0	7.0	1.840	6.508	0.283	10,800
				5.1	1.171	4.005	0.292	12,600
				4.1	0.836	2.578	0.324	15,800
				3.1	0.544	1.652	0.329	18,600

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-21B	106.4	19.7	7.0	2.0	0.418	0.926	0.451	22,100
				1.0	0.167	0.375	0.445	27,600
				0.5	0.042	0.138	0.304	37,200
			4.0	7.0	1.880	6.106	0.308	11,500
				5.0	1.254	3.754	0.334	13,300
				4.0	0.919	2.503	0.367	16,100
				3.1	0.585	1.577	0.371	19,500
				2.1	0.418	0.901	0.464	23,400
				1.0	0.167	0.350	0.477	29,200
				0.5	0.084	0.138	0.607	37,200
			2.0	7.0	1.920	6.256	0.307	11,200
				5.0	1.252	3.729	0.336	13,400
				4.1	0.918	2.753	0.334	14,800
				3.1	0.668	1.777	0.376	17,200
				2.0	0.417	1.026	0.407	19,900
				1.0	0.167	0.425	0.393	24,000
				0.5	0.083	0.175	0.477	29,200
			1.0	7.0	1.502	3.053	0.492	23,000
				5.0	1.001	2.027	0.494	24,500
				4.1	0.793	1.551	0.511	26,300
				3.1	0.501	1.076	0.465	28,400
				2.0	0.334	0.676	0.494	30,200
				1.0	0.167	0.275	0.606	37,100
				0.5	0.083	0.113	0.741	47,000
1206-21C	106.1	17.3	7.0	7.1	1.847	6.006	0.307	11,800
				5.1	1.091	3.954	0.276	12,900
				4.1	0.797	2.402	0.332	17,100
				3.1	0.546	1.502	0.363	20,600
				2.1	0.420	0.826	0.508	25,000
				1.0	0.126	0.325	0.387	32,100
				0.5	0.042	0.125	0.335	41,300
			4.0	7.1	1.888	6.055	0.312	11,700
				5.0	1.258	3.703	0.340	13,600
				4.1	0.965	2.452	0.393	16,600
				3.1	0.503	1.526	0.330	20,300
				2.1	0.419	0.851	0.493	25,000
				1.0	0.168	0.300	0.559	34,300
				0.5	0.042	0.125	0.335	41,200
			2.0	7.1	1.886	6.204	0.304	11,400
				5.0	1.257	3.678	0.342	13,600
				4.1	0.922	2.702	0.341	15,200
				3.1	0.587	1.726	0.340	17,900
				2.1	0.419	1.001	0.419	20,600
				1.0	0.168	0.400	0.419	25,700
				0.5	0.084	0.150	0.558	34,300
			1.0	7.1	1.424	3.027	0.470	23,300
				5.0	1.005	2.001	0.502	25,000

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-21C	106.1	17.3	1.0	4.1	0.796	1.526	0.521	26,900
				3.1	0.503	1.051	0.478	29,400
				2.1	0.251	0.650	0.386	31,600
				1.0	0.168	0.275	0.609	37,400
				0.5	0.084	0.075	1.116	71,100
1206-22A	108.4	19	7.0	7.1	0.588	2.701	0.218	26,300
				6.2	0.504	2.126	0.237	29,200
				5.1	0.378	1.626	0.233	31,200
				4.1	0.336	1.251	0.269	33,100
				3.1	0.252	0.875	0.288	35,500
				2.1	0.168	0.525	0.320	39,400
				1.1	0.084	0.225	0.373	46,800
				0.5	0.000	0.100	0.000	51,700
			4.0	6.3	0.504	2.101	0.240	30,100
				5.1	0.420	1.676	0.251	30,400
				4.1	0.336	1.276	0.263	31,900
				3.1	0.210	0.900	0.233	34,400
				2.1	0.168	0.550	0.305	38,100
				1.1	0.084	0.250	0.336	42,300
				0.5	0.042	0.100	0.420	51,600
			2.0	6.3	0.588	2.001	0.294	31,300
				5.0	0.504	1.551	0.325	32,500
				4.1	0.336	1.226	0.274	33,700
				3.1	0.252	0.875	0.288	35,400
				2.1	0.168	0.525	0.320	39,300
				1.0	0.042	0.225	0.186	45,900
				0.5	0.000	0.100	0.000	53,500
			1.0	6.2	0.671	2.126	0.316	29,100
				5.0	0.504	1.626	0.310	31,000
				4.1	0.420	1.276	0.329	32,400
				3.1	0.252	0.875	0.288	35,400
				2.1	0.168	0.525	0.320	39,300
				1.0	0.084	0.225	0.373	46,400
				0.5	0.000	0.100	0.000	54,200
1206-22B	108.0	19.1	7.0	7.1	0.923	3.676	0.251	19,300
				6.2	0.797	3.101	0.257	19,900
				5.0	0.587	2.325	0.252	21,600
				4.2	0.503	1.850	0.272	22,500
				3.1	0.335	1.275	0.263	24,400
				2.1	0.168	0.775	0.216	26,600
				1.1	0.126	0.350	0.359	30,200
				0.6	0.000	0.160	0.000	36,200
			4.0	6.3	0.754	3.151	0.239	20,000
				5.1	0.670	2.475	0.271	20,500
				4.1	0.587	1.950	0.301	21,100
				3.1	0.503	1.350	0.372	22,900
				2.1	0.210	0.875	0.239	24,200

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-22B	108.0	19.1	4.0	1.1	0.126	0.375	0.335	28,100
				0.5	0.042	0.150	0.279	35,600
			2.0	6.2	0.670	3.275	0.205	18,800
				5.0	0.586	2.600	0.225	19,300
				4.1	0.503	2.000	0.251	20,600
				3.1	0.335	1.400	0.239	22,000
				2.0	0.251	0.850	0.296	23,800
				1.0	0.084	0.400	0.209	25,700
				0.5	0.042	0.175	0.239	30,500
			1.0	6.2	0.837	3.325	0.252	18,500
				5.0	0.670	2.500	0.268	20,000
				4.1	0.502	1.950	0.258	21,100
				3.1	0.335	1.400	0.239	22,500
				2.1	0.209	0.825	0.254	24,900
				1.0	0.126	0.375	0.335	27,400
				0.5	0.042	0.160	0.262	32,500
1206-22C	108.6	18.3	7.0	10.3	1.511	5.903	0.256	17,500
				7.1	0.840	3.402	0.247	20,900
				6.2	0.798	2.701	0.295	22,900
				5.0	0.588	1.901	0.309	26,500
				3.1	0.294	0.875	0.336	35,400
				2.1	0.252	0.450	0.559	45,900
				1.0	0.084	0.175	0.480	59,700
			4.0	7.1	0.840	3.002	0.280	23,700
				5.0	0.504	1.701	0.296	29,700
				4.1	0.420	1.276	0.329	32,500
				3.1	0.252	0.825	0.305	37,600
				2.1	0.168	0.475	0.354	43,600
				1.1	0.084	0.200	0.420	52,700
				0.5	0.000	0.075	0.000	70,700
			2.0	6.2	0.588	2.451	0.240	25,300
				5.0	0.504	1.801	0.280	28,000
				4.1	0.378	1.376	0.275	30,100
				3.1	0.294	0.875	0.336	35,400
				2.1	0.168	0.500	0.336	41,300
				1.0	0.084	0.180	0.466	57,400
				0.5	0.000	0.075	0.000	71,400
			1.0	6.2	0.588	2.251	0.261	27,500
				5.0	0.504	1.701	0.296	29,600
				4.1	0.336	1.276	0.263	32,400
				3.1	0.294	0.850	0.345	36,400
				2.1	0.168	0.500	0.336	41,300
				1.0	0.084	0.200	0.420	51,600
				0.5	0.000	0.075	0.000	68,800

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Compactive Effort CE 12								
1206-16A	105.6	13.5	7.0	9.9	0.664	2.500	0.266	39,800
				6.9	0.498	1.650	0.302	42,100
				4.9	0.332	1.050	0.316	46,900
				4.0	0.249	0.840	0.297	48,100
				3.0	0.166	0.600	0.277	50,000
				2.0	0.166	0.390	0.426	51,800
				1.0	0.000	0.180	0.000	56,100
				0.5	0.000	0.075	0.000	68,600
			4.0	10.0	0.747	2.350	0.318	42,400
				6.9	0.498	1.515	0.329	45,800
				4.9	0.249	0.980	0.254	50,200
				4.0	0.216	0.765	0.282	52,800
				3.0	0.083	0.550	0.151	54,500
				2.1	0.000	0.370	0.000	56,200
				1.0	0.000	0.160	0.000	60,700
				0.5	0.000	0.075	0.000	66,400
			2.0	10.1	0.581	2.200	0.264	45,800
				6.8	0.249	1.590	0.156	42,800
				4.9	0.249	1.050	0.237	47,100
				4.0	0.166	0.800	0.207	50,400
				3.0	0.083	0.568	0.146	52,700
				2.0	0.083	0.365	0.227	56,100
				1.0	0.041	0.170	0.244	58,500
				0.5	0.000	0.075	0.000	67,200
			1.0	4.9	0.166	0.910	0.182	54,000
				4.0	0.166	0.770	0.215	52,300
				3.0	0.083	0.570	0.145	51,900
				2.0	0.000	0.375	0.000	53,700
				0.8	0.000	0.150	0.000	56,700
				0.5	0.000	0.075	0.000	65,500
1206-16B	104.4	14.1	7.0	13.9	0.250	4.626	0.054	30,100
				10.1	0.208	3.375	0.062	30,000
				7.9	0.166	2.525	0.066	31,400
				7.0	0.166	2.225	0.075	31,600
				6.1	0.125	1.850	0.067	32,900
				4.9	0.125	1.400	0.089	35,300
				4.0	0.125	1.163	0.107	34,600
				3.0	0.083	0.825	0.101	36,900
				2.0	0.042	0.518	0.080	39,400
				1.0	0.000	0.195	0.000	51,000
			4.0	13.9	0.549	5.150	0.107	27,000
				10.1	0.374	3.800	0.098	26,600
				7.8	0.332	2.850	0.117	27,300
				6.8	0.249	2.400	0.104	28,500

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Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-16B	104.4	14.1	4.0	6.0	0.199	2.050	0.097	29,300
				5.0	0.166	1.650	0.101	30,500
				4.0	0.166	1.250	0.133	32,400
				3.1	0.133	0.888	0.150	34,600
				2.0	0.083	0.350	0.237	57,900
			2.0	7.8	1.032	2.750	0.375	28,400
				6.9	0.908	2.400	0.378	28,600
				5.9	0.826	2.038	0.405	29,100
				4.9	0.661	1.575	0.420	31,000
				4.0	0.413	1.220	0.339	32,800
				3.0	0.331	0.880	0.376	34,100
				2.0	0.248	0.525	0.472	38,100
				1.0	0.165	0.255	0.648	39,200
			1.0	4.9	0.264	1.650	0.160	29,400
				4.0	0.247	1.300	0.190	30,600
				3.0	0.165	0.956	0.173	31,300
				2.0	0.000	0.563	0.000	35,400
				1.0	0.000	0.206	0.000	48,300
1206-16C	118.1	14.3	7.0	14.0	0.501	2.980	0.168	47,100
				10.2	0.334	2.000	0.167	51,100
				7.0	0.234	1.300	0.180	54,000
				5.0	0.167	0.850	0.196	58,600
				3.1	0.100	0.500	0.200	61,300
				2.4	0.083	0.363	0.230	65,200
			4.0	14.0	0.751	2.925	0.257	47,900
				10.2	0.667	1.985	0.336	51,400
				7.0	0.417	1.250	0.334	56,100
				5.0	0.167	0.850	0.196	58,900
				3.1	0.100	0.500	0.200	61,200
				2.0	0.083	0.300	0.278	68,000
			2.0	13.9	0.499	2.950	0.169	47,200
				10.1	0.416	1.988	0.209	50,900
				7.0	0.249	1.275	0.196	54,600
				4.9	0.166	0.850	0.196	58,000
				3.0	0.133	0.488	0.273	62,300
				2.0	0.083	0.300	0.277	67,500
			1.0	13.9	0.498	2.800	0.178	49,600
				10.1	0.332	1.938	0.171	52,100
				6.8	0.249	1.200	0.207	56,800
				4.9	0.166	0.825	0.201	59,600
				3.0	0.133	0.470	0.283	64,400
				2.0	0.066	0.300	0.221	68,300
1206-18A	105.4	17.4	7.0	14.0	2.200	6.850	0.321	20,400
				10.2	1.500	4.500	0.333	22,600
				7.0	1.033	2.650	0.390	26,400
				5.0	0.633	1.590	0.398	31,200
				3.1	0.467	0.855	0.546	35,700

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-18A	105.4	17.4	7.0	2.0	0.167	0.505	0.330	40,300
			4.0	13.9	1.860	6.650	0.280	20,900
				10.1	1.246	4.625	0.269	21,900
				7.0	0.914	2.700	0.339	25,800
				4.9	0.748	1.700	0.440	29,000
				3.0	0.374	0.862	0.434	35,300
				2.0	0.266	0.512	0.519	39,600
			2.0	10.1	1.129	4.445	0.254	22,700
				7.9	1.079	3.150	0.343	25,000
				6.1	0.830	2.250	0.369	26,900
				4.8	0.581	1.625	0.358	29,500
				4.0	0.498	1.300	0.383	31,100
				2.0	0.166	0.525	0.316	38,500
			1.0	4.8	0.464	1.425	0.326	33,600
				4.0	0.415	1.150	0.360	35,000
				3.1	0.365	0.775	0.471	39,400
				2.0	0.249	0.425	0.585	47,400
				1.0	0.133	0.175	0.758	57,600
				0.5	0.099	0.070	1.421	67,400
1206-18B	106.9	15.9	7.0	14.0	1.085	3.725	0.291	37,700
				10.2	0.751	2.575	0.292	39,700
				7.0	0.501	1.588	0.315	44,200
				5.0	0.334	1.000	0.334	49,800
				3.1	0.250	0.525	0.477	58,300
				2.0	0.167	0.288	0.581	71,000
			4.0	14.0	1.001	3.750	0.267	37,400
				10.2	0.751	2.550	0.294	40,000
				7.0	0.501	1.600	0.313	43,800
				5.0	0.334	1.000	0.334	49,700
				3.0	0.209	0.537	0.388	56,300
				2.0	0.167	0.300	0.556	68,000
			2.0	10.2	0.667	2.475	0.269	41,100
				8.0	0.500	1.825	0.274	43,600
				6.1	0.417	1.312	0.318	46,500
				5.0	0.333	1.000	0.333	49,600
				4.1	0.250	0.762	0.328	53,400
				2.0	0.083	0.312	0.267	65,200
			1.0	5.0	0.333	0.950	0.351	52,100
				4.1	0.250	0.750	0.333	54,200
				3.0	0.208	0.525	0.397	58,100
				2.0	0.167	0.325	0.512	62,500
				1.0	0.083	0.137	0.606	73,900
				0.5	0.000	0.057	0.000	88,300
1206-18C	107.3	15.9	7.0	13.9	1.162	3.551	0.327	39,100
				10.1	0.830	2.325	0.357	43,400
				6.9	0.540	1.450	0.372	47,900
				4.9	0.332	0.975	0.340	50,500

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-18C	107.3	15.9	7.0	3.0	0.208	0.550	0.377	55,100
				2.0	0.166	0.340	0.488	59,400
			4.0	13.9	1.245	3.450	0.361	40,200
				10.1	0.913	2.400	0.380	42,000
				6.9	0.539	1.500	0.360	46,200
				4.9	0.332	0.988	0.336	49,800
				3.0	0.166	0.500	0.332	60,500
				2.0	0.083	0.300	0.277	67,200
			2.0	10.1	0.746	1.963	0.380	51,400
				7.9	0.581	1.463	0.397	53,800
				6.0	0.498	1.088	0.458	55,600
				4.9	0.332	0.800	0.415	60,600
				4.0	0.207	0.638	0.325	62,200
				2.0	0.166	0.300	0.553	67,200
			1.0	4.9	0.373	0.800	0.466	61,300
				4.0	0.332	0.625	0.530	64,400
				3.0	0.249	0.450	0.552	67,100
				2.0	0.166	0.288	0.577	71,100
				1.0	0.083	0.138	0.603	75,500
				0.5	0.000	0.063	0.000	80,500
1206-20A	105.8	18.5	7.0	7.0	1.084	4.251	0.255	16,500
				6.1	1.001	3.626	0.276	16,900
				5.0	0.750	2.788	0.269	17,800
				4.1	0.584	2.150	0.271	18,900
				3.1	0.417	1.425	0.292	21,400
				2.0	0.250	0.850	0.294	24,000
			4.0	6.1	0.917	3.550	0.258	17,200
				5.0	0.750	2.750	0.273	18,000
				4.1	0.583	2.125	0.274	19,100
				3.1	0.417	1.450	0.287	21,000
				2.0	0.250	0.875	0.286	23,300
				1.0	0.167	0.400	0.417	25,900
			2.0	5.0	0.749	2.625	0.285	18,900
				4.1	0.541	2.050	0.264	19,800
				3.0	0.500	1.400	0.357	21,800
				2.0	0.208	0.875	0.238	23,200
				1.0	0.167	0.400	0.416	25,400
				0.5	0.083	0.175	0.476	29,000
			1.0	4.9	0.665	2.600	0.256	19,000
				4.1	0.582	2.050	0.284	19,800
				3.0	0.416	1.450	0.287	21,000
				2.0	0.249	0.900	0.277	22,500
				1.0	0.083	0.413	0.202	24,600
				0.5	0.083	0.185	0.449	27,400
1206-20C	106.1	17.8	7.0	7.0	0.834	2.651	0.315	26,400
				6.1	0.750	2.226	0.337	27,500
				5.0	0.584	1.775	0.329	28,100

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-20C	106.1	17.8	7.0	4.1	0.417	1.388	0.300	29,400
				3.0	0.334	0.975	0.342	30,700
				2.0	0.208	0.613	0.340	33,300
			4.0	6.1	0.666	2.250	0.296	27,100
				5.0	0.500	1.750	0.286	28,400
				4.1	0.417	1.380	0.302	29,600
				3.1	0.333	1.000	0.333	30,800
				2.1	0.250	0.625	0.400	33,000
				1.0	0.167	0.275	0.606	37,000
			2.0	5.0	0.500	1.800	0.278	27,500
				4.1	0.417	1.450	0.287	28,000
				3.1	0.250	1.025	0.244	29,800
				2.0	0.167	0.625	0.267	32,500
				1.0	0.083	0.275	0.303	37,000
				0.5	0.042	0.125	0.333	42,200
			1.0	5.0	0.583	1.800	0.324	27,500
				4.1	0.458	1.425	0.321	28,500
				3.1	0.333	1.000	0.333	30,500
				2.0	0.250	0.575	0.435	35,400
				1.0	0.167	0.250	0.666	40,700
				0.6	0.000	0.125	0.000	45,800

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Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-13A	108.5	11	7.0	17.3	0.829	2.375	0.349	72,900
				13.2	0.663	1.750	0.379	75,500
				10.1	0.497	1.287	0.386	78,200
				6.9	0.663	0.775	0.856	89,300
				4.9	0.249	0.487	0.510	100,700
				3.0	0.166	0.250	0.663	120,800
			4.0	17.6	0.746	2.425	0.308	72,600
				13.5	0.580	1.825	0.318	74,100
				10.1	0.414	1.250	0.332	80,500
				6.9	0.290	0.775	0.374	89,300
				4.9	0.166	0.500	0.332	98,200
				3.0	0.083	0.250	0.332	120,800
			2.0	17.7	0.663	2.450	0.271	72,200
				13.8	0.539	1.825	0.295	75,800
				10.0	0.414	1.237	0.335	81,200
				6.9	0.249	0.762	0.326	90,800
				4.9	0.166	0.500	0.332	98,500
				3.0	0.000	0.275	0.000	110,700
			1.0	17.6	0.663	2.450	0.271	71,900
				13.8	0.497	1.825	0.273	75,800
				10.1	0.414	1.225	0.338	82,200
				6.9	0.273	0.750	0.365	92,300
				4.9	0.207	0.475	0.436	103,300
				3.0	0.124	0.250	0.497	120,800

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-13B	105.1	10.6	7.0	17.5	0.334	2.501	0.133	70,100
				14.0	0.334	1.901	0.176	73,800
				10.6	0.250	1.326	0.189	79,900
				7.0	0.167	0.775	0.215	90,500
				5.1	0.167	0.500	0.334	102,600
				3.1	0.000	0.250	0.000	122,400
				2.1	0.000	0.150	0.000	138,100
				1.0	0.000	0.063	0.000	163,200
			4.0	17.5	0.500	2.501	0.200	70,000
				14.0	0.334	1.926	0.173	72,800
				10.2	0.250	1.326	0.189	76,900
				7.0	0.225	0.775	0.290	90,400
				5.1	0.125	0.513	0.244	99,400
				4.1	0.083	0.400	0.208	102,600
				3.1	0.000	0.275	0.000	111,100
				2.0	0.000	0.163	0.000	125,400
				1.0	0.000	0.070	0.000	145,500
			2.0	10.2	0.267	1.326	0.201	76,900
				6.8	0.167	0.838	0.199	81,700
				5.1	0.125	0.550	0.227	92,600
				3.1	0.083	0.288	0.290	106,300
				2.0	0.000	0.175	0.000	116,400
				1.0	0.000	0.075	0.000	135,800
			1.0	10.2	0.250	1.113	0.225	91,600
				7.0	0.167	0.713	0.234	98,300
				5.2	0.125	0.500	0.250	103,100
				4.1	0.083	0.375	0.222	108,600
				2.0	0.083	0.163	0.513	125,400
				1.0	0.000	0.075	0.000	135,800
1206-15A	117.3	13.9	7.0	18.0	0.503	3.251	0.155	55,300
				14.1	0.419	2.426	0.173	58,300
				10.3	0.335	1.600	0.209	64,200
				7.1	0.168	0.975	0.172	72,600
				5.0	0.084	0.650	0.129	77,700
				3.1	0.042	0.363	0.116	86,000
				2.1	0.000	0.215	0.000	95,700
			4.0	18.0	0.586	3.025	0.194	59,400
				14.1	0.419	2.375	0.176	59,500
				10.3	0.251	1.550	0.162	66,300
				7.1	0.167	0.963	0.174	73,400
				5.0	0.084	0.625	0.134	80,100
				3.1	0.000	0.338	0.000	91,300
				2.1	0.000	0.200	0.000	102,700
				1.0	0.000	0.088	0.000	117,400
			2.0	14.1	0.418	2.275	0.184	62,000
				10.3	0.251	1.600	0.157	64,100

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-15A	117.3	13.9	2.0	7.0	0.167	0.938	0.178	74,500
				5.0	0.125	0.613	0.205	81,600
				3.1	0.084	0.350	0.239	87,900
				2.1	0.042	0.213	0.197	96,500
				1.0	0.000	0.088	0.000	117,100
			1.0	10.3	0.585	1.400	0.418	73,200
				7.0	0.418	0.900	0.465	78,300
				5.0	0.251	0.575	0.436	86,900
				3.1	0.167	0.325	0.515	94,600
				2.1	0.084	0.200	0.418	102,500
				1.0	0.042	0.075	0.558	132,400
1206-15B	113.9	13.4	7.0	17.7	0.796	2.501	0.318	70,700
				14.1	0.587	2.001	0.293	70,700
				10.3	0.503	1.350	0.372	76,200
				7.2	0.377	0.850	0.443	84,700
				5.1	0.251	0.550	0.457	92,300
				3.2	0.084	0.313	0.268	100,800
				2.1	0.000	0.188	0.000	109,700
				1.1	0.000	0.088	0.000	121,200
			4.0	18.0	1.089	2.976	0.366	60,500
				14.2	0.838	2.326	0.360	60,800
				10.3	0.587	1.501	0.391	68,600
				7.3	0.419	0.900	0.465	80,700
				5.0	0.210	0.563	0.372	89,200
				4.2	0.168	0.450	0.372	94,300
				3.1	0.126	0.300	0.419	102,900
				2.1	0.084	0.188	0.447	111,500
			2.0	14.1	0.838	2.326	0.360	60,800
				10.3	0.503	1.450	0.347	70,900
				7.1	0.419	0.875	0.479	80,800
				5.0	0.251	0.575	0.437	87,200
				3.1	0.168	0.325	0.515	94,900
				2.0	0.084	0.200	0.419	101,200
				1.0	0.000	0.088	0.000	117,500
			1.0	10.3	0.670	1.450	0.462	70,800
				7.1	0.502	0.888	0.566	79,600
				5.0	2.931	0.588	4.987	85,200
				3.1	0.167	0.338	0.496	91,300
				2.1	0.084	0.206	0.406	99,600
				1.0	0.042	0.088	0.478	113,700
				0.5	0.000	0.040	0.000	136,400
1206-15C	115.7	13.5	7.0	18.1	0.752	2.075	0.362	87,000
				13.7	0.668	1.363	0.490	100,900
				10.2	0.501	0.888	0.565	115,200
				7.0	0.418	0.525	0.796	133,900
				5.0	0.334	0.325	1.028	153,400
				3.1	0.209	0.180	1.160	171,500

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-15C	115.7	13.5	7.0	2.1	0.125	0.110	1.139	188,300
			4.0	18.0	0.751	2.150	0.349	83,500
				13.9	0.543	1.390	0.390	99,900
				10.2	0.417	0.888	0.470	115,100
				7.2	0.334	0.575	0.581	124,900
				5.0	0.000	0.363	0.000	137,400
				4.1	0.167	0.288	0.581	142,100
				2.0	0.083	0.125	0.668	163,400
				1.0	0.000	0.050	0.000	204,300
			2.0	14.0	0.667	1.325	0.504	105,900
				10.2	0.501	0.875	0.572	116,600
				6.9	0.334	0.550	0.607	126,400
				5.0	0.250	0.363	0.690	137,200
				3.1	0.125	0.213	0.589	145,500
				2.0	0.000	0.130	0.000	156,000
				1.1	0.000	0.063	0.000	168,300
			1.0	10.2	0.542	0.888	0.610	114,600
				7.0	0.417	0.575	0.725	121,600
				5.0	0.208	0.388	0.538	128,000
				3.1	0.125	0.213	0.588	143,600
				2.1	0.042	0.138	0.303	150,300
				1.0	0.000	0.063	0.000	167,900
				0.5	0.000	0.025	0.000	211,100
1206-17A	113.9	14.9	7.0	14.1	0.585	2.500	0.234	56,400
				10.1	0.418	1.550	0.270	64,900
				7.0	0.251	0.950	0.264	74,200
				6.1	0.209	0.800	0.261	76,900
				5.0	0.167	0.625	0.268	79,900
				3.1	0.125	0.363	0.346	84,800
				2.0	0.084	0.225	0.372	91,100
			4.0	14.1	0.585	2.400	0.244	58,700
				10.2	0.418	1.625	0.257	63,100
				6.7	0.209	0.900	0.232	74,700
				5.0	0.167	0.575	0.291	86,900
				3.1	0.084	0.313	0.268	98,400
				2.1	0.000	0.200	0.000	104,100
			2.0	10.2	0.543	1.600	0.339	64,000
				7.0	0.418	0.988	0.423	71,300
				5.0	0.335	0.625	0.535	79,900
				3.1	0.167	0.350	0.478	87,800
				2.1	0.084	0.225	0.372	92,500
				1.0	0.084	0.100	0.836	102,500
			1.0	10.2	0.753	1.525	0.493	67,200
				7.0	0.502	0.925	0.542	76,200
				5.0	0.335	0.613	0.546	81,600
				3.1	0.251	0.350	0.717	87,800
				2.0	0.167	0.225	0.743	91,100

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-17A	113.9	14.9	1.0	1.0	0.084	0.100	0.836	102,500
				0.5	0.000	0.038	0.000	136,600
1206-17B	116.1	14.9	7.0	14.1	0.670	2.400	0.279	58,800
				10.3	0.502	1.500	0.335	68,400
				7.1	0.335	0.900	0.372	78,400
				5.0	0.209	0.600	0.349	83,400
				3.1	0.167	0.338	0.496	91,300
				2.1	0.084	0.213	0.394	96,600
				1.1	0.042	0.100	0.418	105,900
			4.0	14.2	0.753	2.500	0.301	56,900
				10.3	0.502	1.725	0.291	59,400
				7.0	0.335	1.125	0.297	62,600
				4.9	0.251	0.750	0.335	65,800
				4.1	0.209	0.600	0.348	68,300
				3.1	0.167	0.425	0.394	72,400
				2.1	0.000	0.263	0.000	78,100
			2.0	10.3	0.502	1.725	0.291	59,400
				7.0	0.418	1.075	0.389	65,600
				5.0	0.251	0.688	0.365	72,700
				3.1	0.167	0.388	0.432	79,400
				2.1	0.084	0.225	0.372	91,100
				1.0	0.084	0.100	0.836	102,500
			1.0	10.2	0.502	1.575	0.318	65,000
				7.0	0.334	0.975	0.343	72,200
				5.0	0.251	0.613	0.409	81,500
				3.1	0.167	0.338	0.495	91,100
				2.1	0.084	0.213	0.393	97,000
				1.0	0.042	0.090	0.464	113,800
				0.5	0.000	0.038	0.000	136,600
1206-17C	114.9	14.4	7.0	14.1	0.544	2.550	0.213	55,400
				10.3	0.377	1.600	0.236	64,200
				7.1	0.251	0.975	0.258	72,500
				5.0	0.084	0.588	0.143	85,300
				3.1	0.042	0.338	0.124	91,400
				2.1	0.042	0.213	0.197	96,700
				1.0	0.000	0.094	0.000	109,600
			4.0	14.1	0.419	2.375	0.176	59,400
				9.9	0.335	1.525	0.220	65,200
				6.7	0.251	0.938	0.268	71,900
				5.0	0.167	0.625	0.268	80,100
				4.1	0.084	0.475	0.176	86,500
				3.1	0.042	0.338	0.124	91,300
				2.1	0.000	0.213	0.000	99,700
			2.0	10.3	0.335	1.625	0.206	63,200
				7.1	0.251	1.000	0.251	70,600
				5.0	0.167	0.650	0.258	77,500
				3.1	0.084	0.375	0.223	82,100

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1206-17C	114.9	14.4	2.0	2.0	0.084	0.238	0.352	86,200
				1.0	0.000	0.106	0.000	96,600
			1.0	10.3	0.335	1.650	0.203	62,200
				6.9	0.209	1.000	0.209	69,300
				5.0	0.167	0.675	0.248	74,200
				3.1	0.084	0.375	0.223	82,100
				2.1	0.042	0.238	0.176	86,500
				1.0	0.000	0.100	0.000	99,500
				0.5	0.000	0.045	0.000	114,100

Thawed Frozen Samples

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
M5-1A	106.5	22.6	7.0	4.0	16.556	36.364	0.455	1,100
				3.0	11.258	24.252	0.464	1,200
				2.0	6.291	14.652	0.429	1,400
				1.5	3.974	9.600	0.414	1,600
				1.0	1.159	5.053	0.229	2,000
				0.5	0.894	2.021	0.442	2,500
			4.0	4.0	16.513	36.458	0.453	1,100
				3.0	13.210	29.369	0.450	1,000
				2.0	9.247	18.229	0.507	1,100
				1.5	6.275	13.469	0.466	1,100
				1.0	2.972	6.076	0.489	1,600
				0.5	1.321	2.329	0.567	2,100
			2.0	4.0	18.140	39.588	0.458	1,000
				3.0	14.842	29.437	0.504	1,000
				2.0	9.235	18.779	0.492	1,100
				1.5	6.596	12.384	0.533	1,200
				1.0	4.123	7.715	0.534	1,300
				0.5	1.583	2.030	0.780	2,500
			1.0	4.0	19.758	38.628	0.512	1,000
				3.0	14.819	29.479	0.503	1,000
				2.0	9.550	18.806	0.508	1,100
				1.5	7.245	13.418	0.540	1,100
				1.0	3.787	8.234	0.460	1,200
				0.5	1.317	2.745	0.480	1,700
M5-1B	104.1	24.1	7.0	4.1	22.047	44.426	0.496	900
				3.0	16.453	34.330	0.479	900
				2.0	10.859	21.708	0.500	900
				1.5	7.239	14.136	0.512	1,100
				1.0	4.278	8.078	0.530	1,200
				0.5	1.547	3.231	0.479	1,500
			4.0	4.0	24.631	47.590	0.518	800
				3.0	19.705	36.958	0.533	800
				2.0	13.136	25.314	0.519	800
				1.5	9.195	17.821	0.516	800
				1.0	4.598	8.607	0.534	1,100
				0.5	2.135	3.746	0.570	1,300

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
M5-1B	104.1	24.1	2.0	3.9	25.553	45.114	0.566	900
				3.0	19.656	36.496	0.539	800
				1.9	13.104	23.317	0.562	800
				1.5	9.828	17.539	0.560	800
				1.0	5.242	8.516	0.616	1,200
				0.5	2.293	4.055	0.566	1,200
			1.0	3.9	27.778	47.718	0.582	800
				2.9	21.569	37.565	0.574	800
				2.0	14.379	25.382	0.567	800
				1.5	10.621	18.275	0.581	800
				1.0	5.719	8.528	0.671	1,100
				0.5	0.000	2.437	0.000	2,000
M5-2A	104.6	23.4	7.0	4.0	19.618	40.609	0.483	1,000
				2.9	15.040	30.457	0.494	1,000
				2.0	9.482	19.797	0.479	1,000
				1.5	6.539	13.706	0.477	1,100
				1.0	2.861	5.888	0.486	1,700
				0.5	1.144	2.437	0.470	2,000
			4.0	3.9	20.551	42.700	0.481	900
				2.9	14.679	32.534	0.451	900
				1.9	10.928	22.367	0.489	900
				1.5	8.318	16.267	0.511	900
				1.0	4.893	9.658	0.507	1,000
				0.5	1.957	4.067	0.481	1,200
			2.0	3.9	21.827	43.788	0.498	900
				2.9	17.591	35.643	0.494	800
				2.0	12.053	23.932	0.504	800
				1.5	8.958	17.822	0.503	900
				1.0	5.375	10.645	0.505	900
				0.5	2.036	4.258	0.478	1,100
			1.0	3.9	22.777	44.636	0.510	900
				2.9	17.896	40.578	0.441	700
				1.9	12.365	28.405	0.435	700
				1.4	8.948	18.767	0.477	700
				1.0	5.369	11.159	0.481	900
				0.5	2.115	4.311	0.491	1,100
M5-2B	106.0	22.8	7.0	4.0	19.910	38.732	0.514	1,000
				3.0	15.265	30.181	0.506	1,000
				2.0	9.457	19.618	0.482	1,000
				1.5	6.471	13.078	0.495	1,200
				1.0	3.650	7.243	0.504	1,400
				0.5	1.161	2.364	0.491	2,100
			4.0	4.0	21.523	43.277	0.497	900
				3.0	16.887	33.213	0.508	900
				2.0	11.755	23.148	0.508	900
				1.5	8.278	17.110	0.484	900

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
M5-2B	106.0	22.8	4.0	1.0	5.298	10.064	0.526	1,000
				0.5	1.821	3.824	0.476	1,300
			2.0	4.0	23.125	43.325	0.534	900
				3.0	18.170	34.761	0.523	900
				2.0	12.554	24.181	0.519	800
				1.5	9.085	17.632	0.515	900
				1.0	5.781	10.848	0.533	900
				0.5	2.147	4.359	0.493	1,200
			1.0	4.0	23.101	44.634	0.518	900
				3.0	18.811	36.519	0.515	800
				2.0	13.200	25.360	0.521	800
				1.5	9.735	18.259	0.533	800
				1.0	6.270	11.666	0.537	900
				0.5	2.475	4.768	0.519	1,000

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1232 SUBGRADE

Frozen

Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M4-1A	107.8	18.9	27.5	10.0	5.2	0.130	394,900
					10.3	0.303	339,700
					15.1	0.455	331,000
					19.8	0.607	326,600
					30.1	1.041	289,400
					39.6	1.627	243,600
					50.7	2.257	224,800
					69.8	3.694	188,800
					88.8	5.306	167,300
			23.0	10.0	10.3	0.152	679,000
					15.1	0.238	632,000
					19.8	0.325	610,000
					30.1	0.498	604,500
					39.6	0.726	546,100
					50.7	0.997	509,000
					69.8	1.517	459,900
					88.8	2.167	409,700
					120.5	3.339	360,900
			19.0	10.0	15.1	0.173	868,500
					19.8	0.206	962,300
					30.1	0.314	958,400
					39.6	0.434	914,200
					50.7	0.628	807,400
					69.8	0.932	748,700
					88.8	1.343	660,800
					120.5	1.929	624,600
M4-1B	107.5	18.8	27.5	10.0	5.1	0.120	429,800
					10.3	0.260	395,800
					15.0	0.434	346,900
					19.8	0.607	326,000
					30.1	1.085	277,400
					39.6	1.562	253,400
					50.7	2.172	233,300
					69.7	3.566	195,400
					88.7	5.226	169,700
			23.0	10.0	10.3	0.141	730,800
					15.0	0.217	694,200
					19.8	0.292	676,900
					30.1	0.444	677,500
					39.6	0.596	664,600
					50.7	0.769	659,000
					69.7	1.127	618,500
					88.7	1.495	593,200
					120.4	2.254	534,000
			19.0	10.0	15.0	0.152	992,100
					19.8	0.227	870,300
					30.1	0.357	841,800

Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M4-1B	107.5	18.8	19.0	10.0	39.6	0.477	830,700
					50.7	0.617	820,800
					69.7	0.910	765,800
					88.7	1.213	731,000
					114.0	1.733	657,800
M4-2A	106.6	19.3	27.5	10.0	5.2	0.109	474,400
					10.3	0.227	454,300
					15.1	0.444	340,100
					19.9	0.650	305,700
					30.2	1.127	268,000
					39.8	1.735	229,100
					50.9	2.476	205,500
					70.0	3.699	189,100
					89.0	5.664	157,200
			23.0	10.0	10.3	0.108	953,800
					15.1	0.173	871,600
					19.9	0.238	834,000
					30.2	0.412	734,000
					39.8	0.563	705,700
					50.9	0.737	690,800
					70.0	1.148	609,300
					89.0	1.647	540,800
					119.3	2.601	458,600
			19.0	10.0	10.3	0.076	1,362,800
					15.1	0.119	1,267,500
					19.9	0.184	1,079,200
					30.2	0.314	961,600
					39.8	0.444	895,100
					50.9	0.607	838,800
					70.0	0.910	768,900
					89.0	1.300	685,000
					119.3	2.037	585,500
M4-2B	107.6	18.3	27.5	10.0	10.4	0.303	341,400
					15.1	0.477	317,500
					19.9	0.715	278,500
					30.3	1.214	249,400
					39.8	1.691	235,500
					51.0	2.386	213,600
					70.1	3.909	179,300
					89.2	5.438	164,100
			23.0	10.0	10.4	0.087	1,189,800
					15.1	0.163	927,400
					19.9	0.239	832,500
					30.3	0.424	713,800
					39.8	0.631	631,600
					51.0	0.870	586,100
					70.1	1.392	503,600

Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M4-2B	107.6	18.3	23.0	10.0	89.2	1.914	466,100
					121.1	3.047	397,500
M6-1A	105.6	18.9	23.0	10.0	5.2	0.076	682,100
					10.4	0.174	596,900
					15.2	0.260	583,400
					20.0	0.401	497,900
					30.3	0.737	411,700
					39.9	1.040	383,600
					51.1	1.518	336,600
					70.2	2.516	279,200
					90.2	3.473	259,700
					119.7	5.737	208,700
			18.5	10.0	10.4	0.052	1,995,300
					15.2	0.119	1,272,800
					20.0	0.162	1,228,200
					30.3	0.260	1,166,800
					39.9	0.368	1,083,700
					51.1	0.498	1,025,200
					70.2	0.780	900,600
					89.4	1.083	825,300
					122.1	1.734	704,500
M6-1B	107.1	19.2	27.5	10.0	5.2	0.198	261,400
					10.3	0.571	180,900
					15.1	0.998	151,300
					19.9	1.564	127,000
					30.2	2.831	106,600
					39.7	4.369	90,900
					50.4	5.695	88,600
					69.9	8.999	77,700
			23.0	10.0	15.1	0.263	573,000
					19.9	0.351	565,500
					30.2	0.549	550,100
					39.7	0.768	517,000
					50.8	1.010	503,400
					69.9	1.493	468,200
					90.5	2.196	412,300
					117.5	3.384	347,400
M6-3A	104.7	19.4	27.5	10.0	5.2	0.119	435,400
					10.4	0.303	342,100
					15.2	0.564	269,000
					20.0	0.998	199,900
					30.3	1.827	166,000
					39.9	2.485	160,600
					51.1	3.361	152,000
					70.2	4.815	145,900
			23.0	10.0	10.4	0.054	1,910,900
					15.1	0.108	1,396,400

Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
M6-3A	104.7	19.4	23.0	10.0	19.9	0.173	1,149,100
					30.3	0.325	930,900
					39.8	0.520	765,600
					51.0	0.737	691,700
					70.1	1.083	647,100
					89.2	1.647	541,800
					116.3	2.688	432,700
			19.0	10.0	15.1	0.065	2,328,400
					19.9	0.108	1,838,600
					30.3	0.217	1,397,300
					39.8	0.347	1,149,100
					51.0	0.477	1,069,700
					70.1	0.780	898,800
					89.2	1.083	823,600
					120.3	1.690	711,700
M6-3B	104.7	20.2	27.5	10.0	5.2	0.065	790,400
					10.3	0.217	476,800
					15.1	0.390	387,100
					19.9	0.629	316,000
					29.8	1.259	236,800
					39.8	1.739	228,600
					49.3	2.262	217,900
					68.4	3.356	203,700
			23.0	10.0	5.2	0.043	1,192,100
					9.9	0.098	1,018,900
					15.1	0.152	995,600
					19.9	0.217	917,500
					30.2	0.347	871,600
					39.8	0.520	764,500
					50.9	0.693	734,000
					70.0	1.040	672,800
					89.0	1.473	604,300
					114.5	2.341	489,100
			18.7	10.0	10.3	0.130	795,000
					15.1	0.217	697,100
					19.9	0.303	655,300
					31.0	0.455	681,500
					40.5	0.585	693,200
					50.9	0.737	690,700
					70.0	1.040	672,700
					89.0	1.343	662,900
					116.1	1.820	637,700

1232 SUBGRADE

Unfrozen

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-14A	109.8	13.1	7.0	1.01	0.000	0.150	0.000	67,500
				3.04	0.083	0.500	0.166	60,700
				4.05	0.166	0.725	0.229	55,900
				5.06	0.249	0.925	0.270	54,700
				6.96	0.332	1.375	0.242	50,600
				9.17	0.415	1.900	0.219	48,300
				10.44	0.499	2.250	0.222	46,400
				13.92	0.582	3.100	0.188	44,900
			4.0	1.01	0.033	0.140	0.237	72,200
				2.02	0.066	0.300	0.221	67,400
				3.03	0.133	0.500	0.266	60,700
				4.04	0.166	0.700	0.237	57,800
				5.06	0.199	0.900	0.221	56,200
				6.95	0.249	1.325	0.188	52,500
				10.11	0.415	2.050	0.203	49,300
			2.0	1.01	0.000	0.150	0.000	67,300
				2.02	0.100	0.315	0.316	64,100
				3.03	0.133	0.500	0.266	60,600
				4.04	0.166	0.700	0.237	57,700
				5.05	0.199	0.890	0.224	56,700
				6.94	0.332	1.300	0.255	53,400
				7.89	0.365	1.500	0.243	52,600
			1.0	1.01	0.066	0.140	0.474	71,900
				2.01	0.133	0.300	0.442	67,100
				3.02	0.166	0.475	0.349	63,600
				4.03	0.199	0.675	0.295	59,700
				5.04	0.332	0.875	0.379	57,500
				6.92	0.398	1.250	0.318	55,400
1232-14B	111.4	12.9	7.0	1.02	0.000	0.130	0.000	78,500
				3.06	0.067	0.410	0.163	74,600
				5.10	0.100	0.760	0.132	67,100
				7.01	0.134	1.150	0.116	61,000
				8.93	0.200	1.600	0.125	55,800
				10.52	0.234	1.950	0.120	54,000
				14.03	0.334	2.650	0.126	52,900
			4.0	1.02	0.000	0.120	0.000	84,900
				2.04	0.033	0.250	0.133	81,500
				4.08	0.067	0.570	0.117	71,500
				5.10	0.100	0.800	0.125	63,700
				7.01	0.167	1.200	0.139	58,400
				7.96	0.200	1.400	0.143	56,900
				10.19	0.267	1.900	0.140	53,600
				12.10	0.334	2.300	0.145	52,600
			2.0	1.02	0.067	0.130	0.512	78,100
				3.05	0.166	0.450	0.370	67,700
				5.08	0.266	0.850	0.313	59,700

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-14B	111.4	12.9	2.0	6.98	0.383	1.250	0.306	55,800
				8.89	0.416	1.650	0.252	53,800
				10.16	0.499	1.900	0.263	53,400
			1.0	1.01	0.000	0.130	0.000	78,000
				2.03	0.100	0.290	0.344	69,900
				3.04	0.166	0.450	0.370	67,600
				4.05	0.233	0.625	0.373	64,900
				5.07	0.299	0.825	0.363	61,400
				6.97	0.366	1.200	0.305	58,100
1232-14C	111.4	13.0	7.0	3.06	0.100	0.340	0.295	90,100
				5.11	0.167	0.650	0.257	78,500
				7.02	0.234	1.050	0.223	66,900
				8.94	0.267	1.425	0.187	62,700
				10.53	0.367	1.750	0.210	60,200
				14.04	0.534	2.451	0.218	57,300
			4.0	1.02	0.000	0.100	0.000	102,000
				2.04	0.067	0.220	0.303	92,700
				4.08	0.150	0.550	0.273	74,200
				5.10	0.184	0.750	0.245	68,000
				7.02	0.250	1.100	0.228	63,800
				7.97	0.300	1.300	0.231	61,300
				10.20	0.367	1.750	0.210	58,300
				12.12	0.417	2.150	0.194	56,300
			2.0	2.04	0.067	0.260	0.256	78,300
				3.06	0.133	0.440	0.303	69,400
				4.08	0.167	0.625	0.267	65,200
				6.05	0.233	1.000	0.233	60,500
				7.96	0.334	1.400	0.238	56,800
				10.19	0.467	1.825	0.256	55,800
			1.0	1.02	0.033	0.140	0.238	72,600
				2.03	0.100	0.320	0.312	63,500
				3.05	0.133	0.500	0.266	61,000
				4.07	0.200	0.700	0.286	58,100
				5.08	0.267	0.900	0.296	56,500
				6.99	0.416	1.300	0.320	53,700
1232-15A	111.0	14.4	7.0	1.03	0.084	0.520	0.161	19,700
				2.05	0.251	1.213	0.207	16,900
				3.08	0.419	2.080	0.201	14,800
				4.11	0.670	2.947	0.227	13,900
				5.13	0.837	4.074	0.205	12,600
				7.06	1.339	5.807	0.231	12,200
			4.0	1.02	0.167	0.563	0.297	18,200
				2.05	0.334	1.322	0.253	15,500
				3.07	0.502	2.167	0.232	14,200
				4.10	0.753	3.294	0.228	12,400
				5.12	1.087	4.334	0.251	11,800
				7.04	1.505	6.154	0.245	11,400

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-15A	111.0	14.4	2.0	1.02	0.134	0.477	0.280	21,400
				2.04	0.334	1.387	0.241	14,700
				3.07	0.535	2.253	0.237	13,600
				4.09	0.835	3.293	0.254	12,400
				5.11	1.086	4.334	0.251	11,800
			1.0	1.02	0.083	0.520	0.160	19,600
				1.53	0.167	0.867	0.193	17,600
				2.04	0.250	1.300	0.193	15,700
				3.06	0.334	2.167	0.154	14,100
				4.08	0.584	3.120	0.187	13,100
1232-15B	110.8	14.1	7.0	1.03	0.084	0.300	0.279	34,200
				2.05	0.167	0.650	0.257	31,500
				3.08	0.335	1.100	0.304	27,900
				4.10	0.502	1.601	0.314	25,600
				5.13	0.669	2.151	0.311	23,800
				7.05	0.920	3.201	0.287	22,000
				9.30	1.171	4.402	0.266	21,100
			4.0	1.02	0.083	0.275	0.303	37,100
				2.04	0.167	0.650	0.257	31,400
				3.06	0.250	1.101	0.228	27,800
				4.05	0.334	1.551	0.215	26,100
				5.11	0.668	2.201	0.303	23,200
				7.02	0.918	3.402	0.270	20,600
				9.25	1.002	4.603	0.218	20,100
			2.0	1.02	0.000	0.200	0.000	50,800
				2.03	0.000	0.550	0.000	37,000
				3.05	0.000	1.001	0.000	30,500
				4.07	0.000	1.501	0.000	27,100
				5.09	0.000	2.102	0.000	24,200
				6.99	0.167	3.252	0.051	21,500
			1.0	1.02	0.000	0.200	0.000	50,800
				2.03	0.000	0.575	0.000	35,400
				3.05	0.000	1.051	0.000	29,000
				4.07	0.000	1.501	0.000	27,100
				5.09	0.000	2.001	0.000	25,400
				6.99	0.000	3.002	0.000	23,300
1232-15C	112.0	13.8	7.0	1.03	0.101	0.225	0.447	45,700
				2.06	0.168	0.500	0.335	41,100
				3.09	0.251	0.825	0.305	37,400
				4.12	0.335	1.175	0.285	35,000
				5.15	0.469	1.601	0.293	32,100
				7.08	0.670	2.401	0.279	29,500
				9.33	1.006	3.401	0.296	27,400
			4.0	1.03	0.067	0.250	0.268	41,100
				2.06	0.151	0.550	0.274	37,400
				3.08	0.235	0.900	0.260	34,300
				4.11	0.335	1.250	0.268	32,900

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-15C	112.0	13.8	4.0	5.14	0.469	1.701	0.276	30,200
				7.07	0.670	2.551	0.263	27,700
				9.32	0.921	3.501	0.263	26,600
			2.0	1.03	0.067	0.250	0.268	41,000
				2.05	0.167	0.575	0.291	35,700
				3.08	0.268	0.925	0.289	33,300
				4.11	0.352	1.300	0.270	31,600
				5.13	0.469	1.725	0.272	29,700
				7.06	0.753	2.551	0.295	27,700
				9.31	1.038	3.601	0.288	25,800
			1.0	1.03	0.067	0.250	0.268	41,000
				2.05	0.201	0.575	0.349	35,600
				3.08	0.335	0.900	0.372	34,200
				4.10	0.401	1.275	0.315	32,100
				5.13	0.552	1.700	0.325	30,100
				7.05	0.803	2.501	0.321	28,200
1232-15D	110.3	14.3	7.0	1.02	0.084	0.350	0.239	29,200
				2.05	0.167	0.801	0.209	25,600
				3.07	0.334	1.276	0.262	24,100
				4.09	0.501	1.776	0.282	23,100
				5.12	0.535	2.301	0.232	22,200
				7.04	0.836	3.402	0.246	20,700
				9.27	1.170	4.703	0.249	19,700
			4.0	1.02	0.000	0.350	0.000	29,200
				2.04	0.167	0.800	0.209	25,500
				3.07	0.334	1.351	0.247	22,700
				4.09	0.501	1.901	0.264	21,500
				5.11	0.601	2.501	0.240	20,400
				7.03	0.919	3.602	0.255	19,500
			2.0	1.02	0.100	0.375	0.267	27,200
				2.04	0.200	0.851	0.235	24,000
				3.06	0.367	1.401	0.262	21,800
				4.08	0.500	2.001	0.250	20,400
				5.10	0.667	2.702	0.247	18,900
				7.01	0.917	4.003	0.229	17,500
				9.24	1.335	5.304	0.252	17,400
			1.0	1.02	0.083	0.375	0.222	27,100
				2.04	0.167	0.901	0.185	22,600
				3.05	0.333	1.501	0.222	20,300
				4.07	0.500	2.152	0.232	18,900
				5.09	0.667	2.802	0.238	18,200
				7.00	0.917	4.003	0.229	17,500
1232-16A	109.9	15.7	7.0	1.03	0.167	0.901	0.186	11,400
				2.05	0.402	2.103	0.191	9,800
				3.08	0.737	3.455	0.213	8,900
				4.11	1.105	5.207	0.212	7,900
				5.13	1.473	6.809	0.216	7,500

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-16A	109.9	15.7	7.0	7.06	2.343	10.214	0.229	6,900
			4.0	1.03	0.201	1.051	0.191	9,800
				2.05	0.536	2.603	0.206	7,900
				3.08	1.004	4.606	0.218	6,700
				4.11	1.540	6.809	0.226	6,000
				5.13	2.176	9.012	0.241	5,700
				7.05	3.513	13.017	0.270	5,400
			2.0	1.02	0.301	1.252	0.240	8,200
				2.05	0.769	3.104	0.248	6,600
				3.07	1.405	5.407	0.260	5,700
				4.10	2.141	8.011	0.267	5,100
				5.12	2.843	10.514	0.270	4,900
				7.04	4.348	15.521	0.280	4,500
			1.0	1.02	0.234	1.302	0.180	7,900
				2.05	0.735	3.305	0.222	6,200
				3.07	1.237	5.508	0.224	5,600
				4.09	1.838	8.212	0.224	5,000
				5.12	2.507	10.515	0.238	4,900
1232-16B	109	15.7	7.0	1.02	0.201	1.003	0.200	10,200
				2.05	0.569	2.356	0.241	8,700
				3.07	1.104	4.207	0.262	7,300
				4.10	1.756	6.511	0.270	6,300
				5.12	2.508	8.915	0.281	5,700
				7.04	3.678	13.022	0.282	5,400
				9.28	5.351	17.245	0.310	5,400
			4.0	1.02	0.267	1.203	0.222	8,500
				2.04	0.802	3.058	0.262	6,700
				3.07	1.503	5.514	0.273	5,600
				4.09	2.505	8.622	0.291	4,700
				5.11	3.508	12.030	0.292	4,200
				7.03	5.428	17.544	0.309	4,000
				9.26	7.516	23.058	0.326	4,000
			2.0	1.02	0.333	1.353	0.246	7,500
				2.04	0.934	3.659	0.255	5,600
				3.06	1.667	6.515	0.256	4,700
				4.07	2.601	10.024	0.259	4,100
				5.09	3.585	13.833	0.259	3,700
				7.00	5.168	19.546	0.264	3,600
			1.0	1.02	0.133	1.403	0.095	7,200
				2.03	0.500	3.909	0.128	5,200
				3.05	1.066	7.217	0.148	4,200
				4.07	1.749	10.725	0.163	3,800
				5.08	2.565	14.533	0.177	3,500
				6.99	3.831	20.048	0.191	3,500
1232-16C	110	15.6	7.0	1.03	0.201	0.703	0.286	14,600
				2.05	0.535	2.008	0.267	10,200
				3.08	1.004	3.815	0.263	8,100

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-16C	110	15.6	7.0	4.10	1.539	5.723	0.269	7,200
				5.13	2.343	8.032	0.292	6,400
				7.05	3.514	12.048	0.292	5,900
				9.30	5.020	15.763	0.318	5,900
			4.0	1.02	0.267	0.903	0.296	11,300
				2.05	0.702	2.510	0.280	8,200
				3.07	1.337	4.819	0.277	6,400
				4.09	2.173	7.529	0.289	5,400
				5.12	3.042	10.541	0.289	4,900
				7.04	5.014	15.861	0.316	4,400
				9.27	7.019	20.880	0.336	4,400
			2.0	1.02	0.267	1.104	0.242	9,200
				2.04	0.835	3.011	0.277	6,800
				3.06	1.669	6.022	0.277	5,100
				4.08	2.671	9.234	0.289	4,400
				5.10	3.739	12.546	0.298	4,100
				7.02	5.675	17.363	0.327	4,000
			1.0	1.02	0.233	1.204	0.194	8,500
				2.04	0.667	3.312	0.201	6,100
				3.05	1.234	6.524	0.189	4,700
				4.07	2.001	9.535	0.210	4,300
				5.09	2.667	13.047	0.204	3,900
				7.00	4.168	18.266	0.228	3,800
1232-16D	110.7	15.5	7.0	1.02	0.167	0.822	0.203	12,400
				2.05	0.368	1.906	0.193	10,700
				3.07	0.635	3.210	0.198	9,600
				4.09	1.070	5.015	0.213	8,200
				5.12	1.538	6.820	0.225	7,500
				7.04	2.507	10.231	0.245	6,900
				9.28	3.510	14.042	0.250	6,600
			4.0	1.02	0.200	1.003	0.200	10,200
				2.04	0.534	2.557	0.209	8,000
				3.07	1.002	4.413	0.227	6,900
				4.09	1.670	6.619	0.252	6,200
				5.11	2.338	9.227	0.253	5,500
				7.02	3.674	13.740	0.267	5,100
				9.26	4.843	18.052	0.268	5,100
			2.0	1.02	0.300	1.153	0.260	8,800
				2.04	0.734	2.908	0.252	7,000
				3.06	1.401	5.214	0.269	5,900
				4.08	2.136	7.621	0.280	5,400
				5.10	2.936	10.528	0.279	4,800
				7.01	4.338	15.041	0.288	4,700
			1.0	1.02	0.200	1.223	0.164	8,300
				2.04	0.467	3.008	0.155	6,800
				3.05	0.933	5.415	0.172	5,600
				4.07	1.467	8.022	0.183	5,100

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-16D	110.7	15.5	1.0	5.09	2.067	10.729	0.193	4,700
				7.00	3.334	15.241	0.219	4,600
1232-18A	109.3	17.5	7.0	0.51	0.500	1.624	0.308	3,100
				1.02	1.250	4.060	0.308	2,500
				1.53	2.416	7.104	0.340	2,100
				2.03	3.999	11.164	0.358	1,800
				3.05	7.664	19.791	0.387	1,500
				4.07	11.996	28.418	0.422	1,400
				5.09	16.661	38.551	0.432	1,300
			4.0	0.50	0.266	2.031	0.131	2,500
				1.01	0.830	5.382	0.154	1,900
				1.51	2.075	10.662	0.195	1,400
				2.02	3.653	16.450	0.222	1,200
				3.03	7.472	27.924	0.268	1,100
				4.04	11.295	38.587	0.293	1,000
				5.06	14.953	48.731	0.307	1,000
			2.0	0.50	0.232	2.235	0.104	2,200
				1.06	0.828	6.502	0.127	1,600
				1.51	1.656	11.175	0.148	1,300
				2.01	2.981	16.966	0.176	1,200
				3.02	5.963	26.923	0.221	1,100
				4.02	9.111	38.083	0.239	1,100
			1.0	0.50	0.132	2.134	0.062	2,300
				1.00	0.529	5.793	0.091	1,700
				1.50	1.489	11.179	0.133	1,300
				2.00	2.564	16.463	0.156	1,200
				3.01	5.293	26.931	0.197	1,100
				4.01	7.610	35.061	0.217	1,100
1232-18B	109.5	17.5	7.0	0.51	0.301	1.003	0.300	5,100
				1.03	0.753	2.407	0.313	4,300
				1.54	1.238	4.212	0.294	3,700
				2.05	2.007	6.217	0.323	3,300
				3.07	3.680	10.830	0.340	2,800
				4.10	5.520	15.544	0.355	2,600
				5.12	7.025	20.056	0.350	2,600
			4.0	0.51	0.401	1.304	0.307	3,900
				1.02	1.036	3.310	0.313	3,100
				1.53	2.088	5.918	0.353	2,600
				2.04	3.090	8.827	0.350	2,300
				3.07	5.679	15.047	0.377	2,000
				4.09	8.017	20.764	0.386	2,000
				5.11	10.022	26.081	0.384	2,000
			2.0	0.51	0.467	1.505	0.310	3,400
				1.02	1.334	4.015	0.332	2,500
				1.53	2.501	7.226	0.346	2,100
				2.04	4.002	11.542	0.347	1,800
				3.06	7.004	19.070	0.367	1,600

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Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-18B	109.5	17.5	2.0	4.08	10.005	26.095	0.383	1,600
				5.09	13.007	32.619	0.399	1,600
			1.0	0.51	0.567	1.756	0.323	2,900
				1.02	1.567	4.617	0.339	2,200
				1.53	2.834	8.230	0.344	1,900
				2.04	4.500	12.245	0.368	1,700
				3.05	7.334	20.073	0.365	1,500
				4.07	10.001	26.597	0.376	1,500
1232-18C	109.9	17.5	7.0	0.51	0.335	1.059	0.316	4,800
				1.03	0.770	2.420	0.318	4,200
				1.54	1.339	4.034	0.332	3,800
				2.05	2.092	6.051	0.346	3,400
				3.08	4.016	11.295	0.356	2,700
				4.10	5.940	17.144	0.346	2,400
				5.13	8.703	23.697	0.367	2,200
			4.0	0.51	0.434	1.440	0.301	3,500
				1.02	1.102	3.537	0.312	2,900
				1.53	2.170	6.568	0.330	2,300
				2.04	3.421	10.105	0.339	2,000
				3.06	6.508	17.380	0.374	1,800
				4.08	9.012	23.241	0.388	1,800
				5.10	12.015	31.820	0.378	1,600
			2.0	0.51	0.466	1.770	0.263	2,900
				1.02	1.333	4.451	0.299	2,300
				1.52	2.582	8.093	0.319	1,900
				2.03	4.164	12.140	0.343	1,700
				3.05	6.996	20.233	0.346	1,500
				4.07	10.327	28.326	0.365	1,400
				5.08	13.325	36.110	0.369	1,400
			1.0	0.51	0.500	1.821	0.274	2,800
				1.02	1.416	4.754	0.298	2,100
				1.53	2.665	8.598	0.310	1,800
				2.03	4.164	12.948	0.322	1,600
				3.05	7.662	21.748	0.352	1,400
				4.07	10.326	28.727	0.359	1,400
1232-18D	110.0	17.2	7.0	0.51	0.335	1.010	0.332	5,100
				1.03	0.905	2.424	0.373	4,200
				1.54	1.508	4.040	0.373	3,800
				2.06	2.178	5.859	0.372	3,500
				3.08	4.356	10.303	0.423	3,000
				4.11	6.701	15.152	0.442	2,700
				5.14	9.717	22.215	0.437	2,300
			4.0	0.51	0.401	1.215	0.330	4,200
				1.02	1.002	3.087	0.325	3,300
				1.53	1.903	5.567	0.342	2,800
				2.04	3.006	8.299	0.362	2,500
				3.06	5.844	15.384	0.380	2,000

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-18D	110.0	17.2	4.0	4.09	8.349	21.254	0.393	1,900
				5.11	12.031	25.287	0.476	2,000
			2.0	0.51	0.367	1.316	0.279	3,900
				1.02	1.000	3.443	0.290	3,000
				1.53	2.000	6.683	0.299	2,300
				2.04	3.334	10.531	0.317	1,900
				3.05	6.001	18.227	0.329	1,700
				4.07	8.668	25.315	0.342	1,600
				5.09	11.502	32.403	0.355	1,600
			1.0	0.51	0.366	1.519	0.241	3,300
				1.02	0.966	3.849	0.251	2,600
				1.52	2.166	7.293	0.297	2,100
				2.03	3.398	11.243	0.302	1,800
				3.05	5.830	18.232	0.320	1,700
				4.07	7.996	24.309	0.329	1,700
1232-S1	106.1	20.5	7.0	0.50	2.638	5.073	0.520	980
				1.00	6.595	14.000	0.471	710
				1.49	10.718	22.319	0.480	670
				1.99	15.831	32.461	0.488	610
				2.99	23.421	47.667	0.491	630
				4.00	28.081	59.692	0.470	670
			4.0	0.50	2.968	5.174	0.574	960
				1.00	7.585	14.812	0.512	670
				1.49	12.202	24.348	0.501	610
				1.99	16.489	32.464	0.508	610
				2.97	23.023	46.815	0.492	630
			2.0	0.50	3.125	4.887	0.639	1,010
				0.99	7.566	14.255	0.531	700
				1.49	12.171	23.419	0.520	630
				1.98	16.777	32.481	0.517	610
				2.97	24.672	46.838	0.527	630
			1.0	0.49	3.112	4.502	0.691	1,090
				0.98	7.863	12.995	0.605	760
				1.47	12.449	21.999	0.566	670
				1.97	17.037	30.697	0.555	640
				2.95	24.573	45.022	0.546	660
1232-S2	104.7	21.3	7.0	0.50	2.142	4.437	0.483	1,120
				0.99	5.767	11.799	0.489	840
				1.49	8.898	19.161	0.464	780
				1.99	12.194	26.220	0.465	760
				2.99	18.140	39.299	0.462	760
			4.0	0.49	2.449	3.763	0.651	1,300
				0.98	6.529	11.594	0.563	840
				1.46	10.447	19.323	0.541	760
				1.95	13.707	27.475	0.499	710
				2.93	21.220	41.696	0.509	700
			2.0	0.48	2.263	3.492	0.648	1,370

Sample no.	Dry density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
1232-S2	104.7	21.3	2.0	0.96	5.982	11.093	0.539	860
				1.44	9.377	18.488	0.507	780
				1.92	13.583	27.213	0.499	700
				2.88	19.414	41.568	0.467	690
			1.0	0.48	2.257	3.197	0.706	1,490
				0.95	5.804	10.311	0.563	920
				1.43	9.029	17.736	0.509	810
				1.90	12.899	24.954	0.517	760
				2.86	19.351	38.660	0.501	740
1232-S3	106.3	20.3	7.0	0.50	1.656	3.610	0.459	1,390
				1.00	3.974	9.526	0.417	1,050
				1.51	6.623	15.242	0.435	990
				2.01	9.273	21.558	0.430	930
				3.01	13.249	32.083	0.413	940
			4.0	0.50	1.488	3.713	0.401	1,350
				1.00	3.968	9.533	0.416	1,050
				1.50	6.614	15.554	0.425	970
				2.00	8.929	21.075	0.424	950
				3.01	13.228	31.107	0.425	970
			2.0	0.50	1.322	2.860	0.462	1,750
				1.00	3.469	8.229	0.422	1,220
				1.50	5.617	14.050	0.400	1,070
				2.00	7.996	19.569	0.409	1,020
				3.00	11.961	28.602	0.418	1,050
			1.0	0.50	1.321	3.212	0.411	1,560
				1.00	3.634	8.532	0.426	1,170
				1.50	5.946	14.554	0.409	1,030
				2.00	8.259	20.074	0.411	1,000
				3.00	11.893	28.104	0.423	1,070

CLASS 3 SUBBASE

Frozen

Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class3-1	131.5	7.6	28.4	10.0	10.3	0.442	542,200
					15.2	0.834	603,600
					20.1	1.313	1,215,100
					30.5	2.122	1,708,600
					40.1	3.030	1,385,200
					51.3	4.134	763,900
					70.6	5.783	937,600
			19.4	10.0	10.3	0.010	2,285,300
					15.2	0.020	1,628,400
					20.1	0.030	2,410,300
					30.5	0.060	2,363,100
					40.1	0.105	2,348,500
					51.3	0.155	1,878,800
					70.6	0.235	2,020,100
					91.5	0.325	2,363,100
					121.9	0.475	2,571,000
Class3-2	130.7?	6.2?	28.4	10.0	5.1	0.035	2,290,800
					10.3	0.090	4,019,000
					15.2	0.170	3,091,500
					20.0	0.276	3,393,800
					30.5	0.501	2,572,200
					40.1	0.801	2,124,800
					51.3	1.154	2,780,700
					70.5	1.859	4,363,500
			23.0	10.0	10.3	0.030	7,621,100
					14.4	0.050	152,700
					20.0	0.080	132,400
					30.5	0.150	124,200
					40.1	0.250	182,900
					51.3	0.388	232,300
					70.5	0.626	143,700
					91.4	0.851	122,100
					121.8	1.201	10,268,400
			19.4	10.0	15.2	0.035	2,813,900
					20.0	0.050	3,004,100
					30.5	0.090	2,567,000
					40.1	0.125	5,080,700
					51.3	0.180	3,312,400
					70.5	0.270	500,000
					91.4	0.388	3,820,100
					121.8	0.550	6,685,200
Class3-3	126.5	9.3	28.4	10.0	10.3	0.060	1,136,900
					15.3	0.110	893,400
					20.1	0.165	1,461,800
					30.5	0.326	444,300
					40.2	0.526	726,700
					51.4	0.852	607,600

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Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class3-3	131.7	9.3	28.4	10.0	70.7	1.305	379,400
			23.0	10.0	10.3	0.040	1,322,400
					14.5	0.060	1,073,900
					20.1	0.085	3,416,300
					30.5	0.130	1,601,400
					40.2	0.170	1,127,400
					51.4	0.225	2,028,400
					70.7	0.350	2,502,200
					91.6	0.488	2,882,500
					122.2	0.750	1,014,400
			19.4	10.0	15.3	0.035	2,612,000
					20.1	0.050	4,350,500
					30.5	0.090	2,849,400
					40.2	0.130	2,357,700
					51.4	0.185	4,007,000
					70.7	0.275	3,205,600
					91.6	0.400	3,383,700
					122.2	0.575	2,214,800
Class3-4	125.8	10.1	28.4	10.0	10.3	0.085	741,700
					15.3	0.165	606,100
					20.2	0.250	927,100
					30.6	0.413	1,212,500
					40.3	0.601	671,000
					51.6	0.851	805,100
					71.0	1.303	544,500
			23.0	10.0	10.3	0.040	2,578,500
					15.3	0.065	1,790,600
					20.2	0.090	1,418,100
					30.6	0.155	1,312,200
					40.3	0.225	1,975,500
					51.6	0.313	2,238,300
					71.0	0.500	1,166,500
					91.9	0.700	2,355,300
					122.6	1.051	1,650,200
			19.4	10.0	10.3	0.030	3,440,000
					15.3	0.050	2,519,500
					20.2	0.070	2,183,100
					30.6	0.115	2,006,600
					40.3	0.160	2,664,100
					51.6	0.213	2,879,400
					71.0	0.325	2,428,200
					90.3	0.450	1,885,400
					122.6	0.650	3,063,700
Class3-5	128 ?	10 ?	28.4	10.0	5.1	0.050	304,100
					10.3	0.150	222,500
					15.2	0.326	258,200
					20.1	0.476	1,024,200

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Sample no.	Dry density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class3-5	128 ?	10 ?	28.4	10.0	30.5	1.003	421,100
					40.1	1.553	682,800
					51.3	2.308	467,800
					70.6	3.366	209,700
			23.0	10.0	15.2	0.035	4,354,400
					20.1	0.060	2,053,400
					30.5	0.115	1,662,600
					40.1	0.180	1,434,400
					51.3	0.250	2,228,100
					70.6	0.375	2,650,500
					91.5	0.550	1,882,300
					121.9	0.850	3,342,200
			19.4	10.0	14.3	0.043	3,370,400
					19.9	0.065	3,060,700
					30.2	0.105	2,546,500
					39.8	0.140	2,419,200
					50.9	0.185	2,880,000
					70.0	0.275	2,753,000
					90.7	0.375	2,842,100
					121.0	0.525	2,304,000

CLASS 3 SUBBASE

Thawed

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-1	131.5	7.2	7.0	0.5	0.234	0.525	0.446	9,700
				1.0	0.468	1.150	0.407	8,900
				1.5	0.902	1.750	0.516	8,800
				2.0	1.170	2.350	0.498	8,700
				3.1	1.838	3.400	0.541	9,000
				4.1	2.423	4.300	0.564	9,500
			4.0	0.5	0.467	0.851	0.548	6,000
				1.0	1.100	1.777	0.619	5,700
				1.5	1.666	2.603	0.640	5,900
				2.0	2.333	3.405	0.685	6,000
				3.1	3.332	4.506	0.740	6,800
				4.1	4.332	5.607	0.773	7,300
			2.0	0.5	0.631	1.003	0.629	5,000
				1.0	1.395	2.106	0.662	4,800
				1.5	2.225	3.008	0.740	5,000
				2.0	2.823	3.811	0.741	5,300
				3.0	3.985	5.114	0.779	5,900
				4.0	5.147	6.217	0.828	6,500
			1.0	0.5	0.762	1.104	0.690	4,700
				1.0	1.657	2.358	0.703	4,300
				1.5	2.452	3.312	0.740	4,600
				2.0	3.148	4.115	0.765	4,900
				3.0	4.474	5.419	0.826	5,600
				4.0	5.634	6.523	0.864	6,200
	132.1	3.3	7.0	1.0	0.100	0.360	0.278	28,200
				2.0	0.233	0.770	0.303	26,400
				3.1	0.400	1.201	0.333	25,400
				4.1	0.533	1.626	0.328	25,000
				5.1	0.733	2.051	0.357	24,800
				7.0	1.066	2.702	0.395	25,900
				8.9	1.333	3.177	0.420	28,000
			4.0	1.0	0.200	0.550	0.363	18,400
				2.0	0.399	1.201	0.333	16,900
				3.0	0.666	1.801	0.370	16,900
				4.1	0.932	2.377	0.392	17,100
				5.1	1.298	2.902	0.447	17,500
				6.0	1.498	3.403	0.440	17,700
				7.9	2.163	4.303	0.503	18,400
				10.1	2.929	5.204	0.563	19,500
			2.0	1.0	0.266	0.801	0.332	12,600
				2.0	0.665	1.642	0.405	12,300
				3.0	1.163	2.503	0.465	12,100
				4.0	1.661	3.304	0.503	12,200
				5.1	2.226	4.005	0.556	12,600
				6.0	2.758	4.606	0.599	13,000
				7.9	3.905	5.807	0.672	13,600
				10.1	5.484	7.008	0.782	14,400

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-1	132.1	3.3	1.0	0.5	0.166	0.501	0.332	10,100
				1.0	0.432	1.051	0.410	9,600
				1.5	0.730	1.652	0.442	9,200
				2.0	1.062	2.178	0.488	9,300
				3.0	1.743	3.104	0.561	9,800
				4.0	2.324	3.905	0.595	10,300
				5.0	2.987	4.631	0.645	10,900
				6.0	3.569	5.306	0.673	11,300
	132.3	0.8	7.0	3.5	0.000	0.110	0.000	318,700
				5.1	0.000	0.170	0.000	300,000
				7.0	0.000	0.240	0.000	292,100
				8.9	0.000	0.320	0.000	278,900
				10.5	0.000	0.380	0.000	276,800
				14.0	0.000	0.520	0.000	269,700
				17.5	0.000	0.660	0.000	265,600
				21.0	0.000	0.800	0.000	262,900
			4.0	2.0	0.000	0.050	0.000	407,300
				3.1	0.000	0.090	0.000	339,400
				4.1	0.000	0.130	0.000	313,300
				6.0	0.000	0.200	0.000	302,300
				8.0	0.000	0.280	0.000	284,100
				10.2	0.000	0.370	0.000	275,200
				12.1	0.000	0.440	0.000	274,800
			2.0	1.0	0.000	0.025	0.000	406,200
				2.0	0.000	0.055	0.000	369,300
				3.0	0.000	0.090	0.000	338,500
				4.1	0.000	0.125	0.000	325,000
				5.1	0.000	0.160	0.000	317,400
				6.0	0.000	0.200	0.000	301,500
				7.9	0.000	0.280	0.000	283,400
				10.2	0.000	0.360	0.000	282,100
			1.0	1.0	0.000	0.025	0.000	404,400
				2.0	0.000	0.055	0.000	367,600
				3.0	0.000	0.090	0.000	337,000
				4.0	0.000	0.130	0.000	311,100
				5.1	0.000	0.180	0.000	280,800
				6.0	0.000	0.220	0.000	272,900
				7.9	0.000	0.290	0.000	272,400
				10.1	0.000	0.360	0.000	280,800
Class3-2R	132.7	5.1	7.0	1.0	0.101	0.360	0.280	28,700
				1.5	0.134	0.550	0.244	28,100
				2.1	0.201	0.750	0.268	27,500
				3.1	0.302	1.150	0.263	26,900
				4.1	0.470	1.550	0.303	26,600
				5.1	0.502	1.900	0.264	27,000
				7.1	0.789	2.551	0.309	27,800
				9.4	1.074	3.301	0.325	28,300

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-2R	132.7	5.1	4.0	1.0	0.134	0.550	0.244	18,700
				1.5	0.235	0.850	0.276	18,200
				2.1	0.335	1.150	0.292	17,900
				3.1	0.537	1.751	0.307	17,700
				4.1	0.771	2.276	0.339	18,100
				5.2	0.939	2.801	0.335	18,400
				6.1	1.141	3.201	0.356	19,100
				8.1	1.509	4.001	0.377	20,100
			2.0	0.5	0.134	0.400	0.335	12,900
				1.0	0.268	0.840	0.319	12,200
				1.5	0.436	1.275	0.342	12,100
				2.1	0.603	1.701	0.355	12,100
				3.1	0.955	2.501	0.382	12,300
				4.1	1.274	3.201	0.398	12,900
				5.1	1.676	3.801	0.441	13,500
				6.1	2.011	4.502	0.447	13,600
			1.0	0.5	0.201	0.525	0.383	9,800
				1.0	0.435	1.101	0.396	9,300
				1.5	0.670	1.701	0.394	9,100
				2.1	0.938	2.251	0.417	9,100
				3.1	1.507	3.202	0.471	9,600
				4.1	2.010	4.052	0.496	10,100
				5.1	2.512	4.852	0.518	10,600
	132.6	3.2	7.0	1.0	0.000	0.150	0.000	68,700
				2.1	0.084	0.340	0.247	60,600
				3.1	0.134	0.540	0.248	57,200
				4.1	0.201	0.775	0.260	53,100
				5.1	0.235	1.000	0.235	51,500
				7.1	0.335	1.350	0.248	52,400
				9.0	0.435	1.675	0.260	53,500
				10.6	0.503	1.925	0.261	55,200
			4.0	1.0	0.000	0.180	0.000	57,200
				2.1	0.101	0.390	0.258	52,800
				3.1	0.168	0.625	0.268	49,400
				4.1	0.218	0.860	0.253	47,800
				5.1	0.268	1.125	0.238	45,700
				6.1	0.335	1.350	0.248	45,200
				8.0	0.436	1.750	0.249	45,900
				10.3	0.570	2.175	0.262	47,300
			2.0	1.0	0.000	0.220	0.000	46,700
				2.1	0.134	0.500	0.268	41,100
				3.1	0.201	0.770	0.261	40,000
				4.1	0.301	1.050	0.287	39,100
				5.1	0.368	1.350	0.273	38,000
				6.1	0.452	1.620	0.279	37,700
				8.0	0.603	2.100	0.287	38,200
				10.3	0.737	2.600	0.283	39,500

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-2R	132.6	3.2	1.0	0.5	0.067	0.120	0.558	42,700
				1.0	0.134	0.250	0.535	41,000
				1.5	0.167	0.380	0.440	40,500
				2.1	0.268	0.540	0.496	38,000
				3.1	0.435	0.850	0.512	36,200
				4.1	0.535	1.150	0.466	35,700
				5.1	0.636	1.425	0.446	36,000
				6.1	0.770	1.650	0.466	36,900
	132.3	0.8	7.0	3.5	0.000	0.045	0.000	788,600
				5.2	0.000	0.070	0.000	737,400
				7.1	0.000	0.100	0.000	709,800
				9.0	0.000	0.135	0.000	669,100
				10.6	0.000	0.160	0.000	665,400
				14.2	0.000	0.225	0.000	630,900
				17.7	0.000	0.300	0.000	591,500
				21.3	0.000	0.350	0.000	608,400
			4.0	2.1	0.000	0.025	0.000	824,800
				3.1	0.000	0.040	0.000	773,300
				4.1	0.000	0.057	0.000	717,300
				6.1	0.000	0.090	0.000	680,200
				8.1	0.000	0.125	0.000	644,400
				10.3	0.000	0.165	0.000	624,900
				12.2	0.000	0.195	0.000	627,900
			2.0	2.1	0.000	0.025	0.000	823,300
				3.1	0.000	0.040	0.000	771,900
				4.1	0.000	0.055	0.000	748,500
				5.1	0.000	0.075	0.000	686,100
				6.1	0.000	0.093	0.000	660,600
				8.0	0.000	0.130	0.000	618,500
				10.3	0.000	0.165	0.000	623,700
			1.0	2.1	0.000	0.025	0.000	820,600
				3.1	0.000	0.041	0.000	750,500
				4.1	0.000	0.060	0.000	683,800
				5.1	0.000	0.080	0.000	641,100
				6.1	0.000	0.100	0.000	609,000
				8.0	0.000	0.135	0.000	593,600
				10.3	0.000	0.175	0.000	586,100
Class3-3	130.4	8.3	7.0	0.5	0.201	0.525	0.383	9,800
				1.0	0.402	1.149	0.350	8,900
				1.5	0.636	1.799	0.354	8,600
				2.1	0.904	2.399	0.377	8,600
				3.1	1.406	3.398	0.414	9,100
				4.1	1.909	4.398	0.434	9,300
			4.0	0.5	0.434	1.050	0.414	4,900
				1.0	1.002	2.200	0.456	4,600
				1.5	1.587	3.200	0.496	4,800
				2.0	2.088	4.000	0.522	5,100

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-3	130.4	8.3	4.0	3.1	3.007	5.201	0.578	5,900
				4.1	3.842	6.501	0.591	6,300
			2.0	0.5	0.700	1.302	0.538	3,900
				1.0	1.417	2.603	0.544	3,900
				1.5	2.167	3.604	0.601	4,200
				2.0	2.750	4.305	0.639	4,700
				3.1	3.834	5.707	0.672	5,400
				4.1	5.000	7.008	0.714	5,800
			1.0	0.5	0.765	1.403	0.546	3,700
				1.0	1.664	2.605	0.639	3,900
				1.5	2.329	3.607	0.646	4,200
				2.0	3.161	4.409	0.717	4,600
				3.0	4.160	5.611	0.741	5,400
				4.1	5.325	7.013	0.759	5,800
	131.2	6.7	7.0	0.5	0.000	0.120	0.000	42,800
				1.0	0.134	0.260	0.515	39,500
				1.5	0.201	0.475	0.423	32,400
				2.1	0.301	0.700	0.431	29,300
				3.1	0.469	1.200	0.391	25,700
				4.1	0.586	1.599	0.366	25,700
				5.1	0.837	2.099	0.399	24,500
			4.0	0.5	0.100	0.220	0.456	23,300
				1.0	0.268	0.550	0.487	18,600
				1.5	0.401	0.950	0.423	16,200
				2.0	0.535	1.350	0.397	15,200
				3.1	0.903	2.099	0.430	14,600
				4.1	1.238	2.699	0.459	15,200
				5.1	1.673	3.399	0.492	15,100
			2.0	0.5	0.234	0.500	0.468	10,200
				1.0	0.601	1.150	0.523	8,900
				1.5	1.002	1.800	0.557	8,500
				2.0	1.470	2.450	0.600	8,300
				3.1	2.339	3.600	0.650	8,500
				4.1	3.341	4.600	0.726	8,900
				5.1	4.344	5.500	0.790	9,300
			1.0	0.5	0.400	0.750	0.534	6,800
				1.0	1.135	1.701	0.667	6,000
				1.5	1.835	2.652	0.692	5,800
				2.0	2.670	3.402	0.785	6,000
				3.1	4.171	4.703	0.887	6,500
				4.1	5.339	5.603	0.953	7,300
				5.1	7.008	6.204	1.130	8,200
	130.9	2.1	7.0	1.0	0.100	0.475	0.211	21,600
				1.5	0.134	0.725	0.184	21,200
				2.0	0.201	0.975	0.206	21,000
				3.1	0.301	1.450	0.208	21,200
				4.1	0.435	1.900	0.229	21,600

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-3	130.9	2.1	7.0	5.1	0.535	2.200	0.243	23,300
				7.0	0.734	2.700	0.272	26,000
				9.1	1.003	3.401	0.295	26,800
			4.0	1.0	0.134	0.700	0.191	14,600
				1.5	0.234	1.100	0.213	13,900
				2.0	0.301	1.400	0.215	14,600
				3.1	0.568	2.051	0.277	15,000
				4.1	0.735	2.601	0.283	15,700
				5.1	1.036	3.151	0.329	16,200
				6.1	1.170	3.601	0.325	16,900
				8.0	1.604	4.401	0.364	18,200
			2.0	0.5	0.134	0.450	0.297	11,300
				1.0	0.267	0.950	0.281	10,700
				1.5	0.434	1.451	0.299	10,600
				2.0	0.668	1.901	0.351	10,700
				3.1	1.068	2.701	0.396	11,300
				4.1	1.469	3.501	0.420	11,700
				5.1	1.836	4.202	0.437	12,100
				6.1	2.170	4.752	0.457	12,800
			1.0	0.5	0.167	0.550	0.303	9,300
				1.0	0.467	1.201	0.389	8,500
				1.5	0.734	1.801	0.407	8,500
				2.0	1.034	2.401	0.431	8,500
				3.1	1.668	3.402	0.490	9,000
				4.1	2.335	4.202	0.556	9,700
				5.1	2.835	5.002	0.567	10,200
	131.4	1.4	7.0	1.0	0.067	0.350	0.192	29,500
				2.1	0.134	0.800	0.168	25,800
				3.1	0.235	1.200	0.196	25,800
				4.1	0.336	1.600	0.210	25,800
				5.2	0.403	1.925	0.209	26,800
				7.1	0.604	2.551	0.237	27,800
				9.3	0.869	3.300	0.263	28,100
				10.6	1.007	3.601	0.280	29,500
			4.0	1.0	0.101	0.500	0.201	20,600
				2.1	0.201	1.025	0.196	20,100
				3.1	0.335	1.550	0.216	19,900
				4.1	0.520	2.001	0.260	20,600
				5.2	0.671	2.501	0.268	20,600
				6.1	0.805	2.851	0.282	21,500
				8.1	1.140	3.601	0.317	22,400
				10.3	1.476	4.451	0.332	23,100
			2.0	1.0	0.168	0.600	0.279	17,100
				2.1	0.335	1.300	0.258	15,800
				3.1	0.603	1.951	0.309	15,800
				4.1	0.871	2.576	0.338	16,000
				5.1	1.139	3.101	0.367	16,600

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-3	131.4	1.4	2.0	6.1	1.341	3.551	0.377	17,200
				8.0	1.843	4.401	0.419	18,300
				10.3	2.513	5.402	0.465	19,000
			1.0	0.5	0.100	0.340	0.295	15,100
				1.0	0.234	0.740	0.317	13,900
				1.5	0.368	1.175	0.313	13,100
				2.1	0.569	1.575	0.361	13,000
				3.1	0.904	2.351	0.385	13,100
				4.1	1.239	3.001	0.413	13,700
				5.1	1.507	3.551	0.424	14,500
				6.1	1.842	4.001	0.460	15,200
Class3-4	129.6	9.3	7.0	0.5	0.200	0.600	0.333	8,500
				1.0	0.433	1.350	0.321	7,500
				1.5	0.700	2.099	0.333	7,300
				2.0	1.083	2.799	0.387	7,300
				3.1	1.667	3.999	0.417	7,600
				4.1	2.166	5.098	0.425	8,000
			4.0	0.5	0.466	1.001	0.465	5,100
				1.0	1.064	2.101	0.507	4,800
				1.5	1.530	3.002	0.510	5,100
				2.0	1.996	3.902	0.511	5,200
				3.0	2.994	5.403	0.554	5,600
				4.1	3.825	6.704	0.571	6,000
			2.0	0.5	0.630	0.952	0.662	5,300
				1.0	1.327	2.204	0.602	4,600
				1.5	1.990	3.206	0.621	4,700
				2.0	2.487	3.958	0.628	5,100
				3.0	3.482	5.210	0.668	5,800
				4.0	4.560	6.512	0.700	6,200
			1.0	0.5	0.728	1.003	0.726	5,100
				1.0	1.489	2.307	0.646	4,300
				1.5	2.317	3.210	0.722	4,700
				2.0	2.813	4.012	0.701	5,000
				3.0	3.889	5.216	0.746	5,800
				4.0	5.130	6.519	0.787	6,200
	129.8	7.9	7.0	0.5	0.000	0.160	0.000	31,900
				1.0	0.134	0.350	0.382	29,200
				1.5	0.200	0.550	0.364	27,900
				2.0	0.267	0.750	0.356	27,200
				3.1	0.434	1.149	0.378	26,700
				4.1	0.584	1.549	0.377	26,400
				5.1	0.835	1.999	0.418	25,500
			4.0	0.5	0.100	0.280	0.358	18,200
				1.0	0.234	0.650	0.359	15,700
				1.5	0.400	0.999	0.401	15,300
				2.0	0.500	1.349	0.371	15,100
				3.1	0.867	2.049	0.423	14,900

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-4	129.8	7.9	4.0	4.1	1.168	2.699	0.433	15,100
				5.1	1.501	3.198	0.469	15,900
			2.0	0.5	0.200	0.440	0.455	11,600
				1.0	0.467	1.025	0.455	9,900
				1.5	0.800	1.550	0.516	9,800
				2.0	1.200	2.100	0.571	9,700
				3.1	1.999	3.199	0.625	9,500
				4.1	2.832	4.149	0.683	9,800
				5.1	3.666	4.999	0.733	10,200
			1.0	0.5	0.300	0.600	0.499	8,500
				1.0	0.832	1.300	0.640	7,800
				1.5	1.431	2.025	0.707	7,500
				2.0	2.064	2.800	0.737	7,200
				3.0	3.329	4.001	0.832	7,600
				4.1	4.494	5.101	0.881	8,000
				5.1	5.659	6.101	0.928	8,300
	130.5	4.0	7.0	1.0	0.134	0.450	0.298	22,900
				1.5	0.201	0.700	0.287	22,100
				2.1	0.302	0.950	0.318	21,700
				3.1	0.486	1.451	0.335	21,300
				4.1	0.671	1.951	0.344	21,100
				5.1	0.805	2.351	0.342	21,900
				7.1	1.174	3.050	0.385	23,200
				9.2	1.509	3.802	0.397	24,100
			4.0	1.0	0.234	0.700	0.335	14,700
				1.5	0.402	1.051	0.383	14,700
				2.1	0.536	1.401	0.383	14,700
				3.1	0.871	2.101	0.414	14,700
				4.1	1.206	2.751	0.438	14,900
				5.1	1.541	3.302	0.467	15,600
				6.1	1.842	3.802	0.484	16,000
				8.0	2.512	4.802	0.523	16,700
			2.0	0.5	0.200	0.500	0.401	10,200
				1.0	0.468	1.051	0.445	9,700
				1.5	0.818	1.601	0.511	9,600
				2.0	1.136	2.102	0.540	9,700
				3.1	1.804	3.053	0.591	10,000
				4.1	2.505	4.003	0.626	10,200
				5.1	3.090	4.904	0.630	10,400
				6.1	3.674	5.705	0.644	10,600
			1.0	0.5	0.234	0.551	0.424	9,300
				1.0	0.567	1.176	0.482	8,700
				1.5	0.934	1.852	0.505	8,300
				2.0	1.335	2.402	0.556	8,500
				3.1	2.136	3.403	0.628	9,000
				4.1	2.803	4.254	0.659	9,600
				5.1	3.337	4.955	0.674	10,300

Sample no.	Dry Density (psi)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Radial strain x10^-4 (in/in)	Axial strain x10^-4 (in/in)	Resilient Poisson's ratio	Resilient modulus (psi)
Class3-4	131.0	2.4	7.0	1.0	0.067	0.295	0.227	34,800
				2.1	0.168	0.610	0.275	33,700
				3.1	0.235	0.940	0.249	32,800
				4.1	0.302	1.226	0.246	33,600
				5.1	0.402	1.501	0.268	34,300
				7.1	0.536	2.051	0.261	34,500
				9.3	0.735	2.600	0.283	35,600
				10.6	1.675	2.901	0.577	36,500
			4.0	1.0	0.100	0.400	0.251	25,700
				2.1	0.201	0.850	0.236	24,200
				3.1	0.301	1.276	0.236	24,200
				4.1	0.435	1.676	0.260	24,500
				5.1	0.536	2.051	0.261	25,000
				6.1	0.670	2.401	0.279	25,400
				8.0	0.904	3.001	0.301	26,700
				10.3	1.172	3.602	0.325	28,500
			2.0	1.0	0.134	0.525	0.255	19,500
				2.1	0.301	1.101	0.274	18,600
				3.1	0.469	1.676	0.280	18,400
				4.1	0.669	2.201	0.304	18,600
				5.1	0.837	2.701	0.310	19,000
				6.1	1.004	3.102	0.324	19,600
				8.0	1.406	3.802	0.370	21,100
				10.3	1.740	4.602	0.378	22,300
			1.0	0.5	0.067	0.280	0.239	18,300
				1.0	0.167	0.590	0.283	17,300
				1.5	0.268	0.950	0.281	16,200
				2.0	0.401	1.301	0.309	15,700
				3.1	0.635	1.951	0.326	15,700
				4.1	0.870	2.501	0.348	16,400
				5.1	1.104	3.052	0.362	16,800
				6.1	1.338	3.502	0.382	17,400

CLASS 6 SUBBASE

Frozen

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-1	130.9	9.34	28.4	10.0	123.6	0.813	1,520,600
					100.7	0.625	1,609,600
					90.1	0.547	1,645,900
					70.6	0.406	1,737,800
					60.0	0.328	1,828,800
					49.4	0.250	1,976,700
					40.6	0.195	2,078,400
					30.0	0.125	2,400,300
					19.4	0.066	2,923,500
					15.0	0.044	3,429,000
					10.6	0.025	4,235,800
			26.6	10.0	123.6	0.516	2,396,800
					100.7	0.414	2,430,400
					90.1	0.359	2,505,500
					70.6	0.273	2,582,700
					60.0	0.219	2,744,100
					49.4	0.172	2,876,200
					40.6	0.137	2,970,100
					30.0	0.094	3,201,400
					19.4	0.052	3,766,400
					15.0	0.036	4,175,800
					10.6	0.023	4,519,700
			23.0	10.0	123.6	0.336	3,679,000
					100.7	0.258	3,903,600
					90.1	0.225	4,002,000
					70.6	0.167	4,224,200
					60.0	0.134	4,467,400
					49.4	0.106	4,652,900
					40.6	0.083	4,903,700
					30.0	0.058	5,191,800
					19.4	0.034	5,649,900
					15.0	0.024	6,196,700
					10.6	0.016	6,779,900
Class6-2	130.0	9.58	28.4	10.0	123.6	1.407	878,200
					100.7	1.095	919,400
					90.1	0.938	959,700
					70.6	0.719	981,800
					60.0	0.594	1,010,200
					49.4	0.469	1,053,800
					40.6	0.360	1,129,100
					30.0	0.242	1,238,300
					19.4	0.136	1,427,500
					15.0	0.089	1,683,700
					10.6	0.048	2,185,300
			26.6	10.0	123.6	0.578	2,137,500
					100.7	0.438	2,300,000
					90.1	0.383	2,351,800

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-2	130.0	9.58	26.6	10.0	70.6	0.281	2,510,700
					60.0	0.234	2,560,900
					49.4	0.188	2,636,200
					40.6	0.145	2,809,200
					30.0	0.100	3,001,000
					19.4	0.055	3,550,800
					15.0	0.039	3,841,300
					10.6	0.023	4,519,200
			23.0	10.0	123.6	0.359	3,439,100
					100.7	0.281	3,578,300
					90.1	0.247	3,647,400
					70.6	0.188	3,766,600
					60.0	0.155	3,880,700
					49.4	0.123	4,005,000
					40.6	0.098	4,158,300
					30.0	0.069	4,365,800
					19.4	0.043	4,519,900
					15.0	0.032	4,685,300
					10.6	0.022	4,842,800
Class6-3	128.4	10.12	28.4	10.0	123.8	0.609	2,031,300
					100.8	0.469	2,150,300
					90.2	0.406	2,219,900
					70.8	0.297	2,382,600
					60.1	0.234	2,565,200
					49.5	0.180	2,755,500
					40.7	0.117	3,470,600
					30.1	0.059	5,063,000
					19.5	0.031	6,224,500
					15.0	0.022	6,871,200
					10.6	0.013	8,487,900
			26.6	10.0	123.8	0.445	2,779,900
					100.8	0.352	2,867,200
					90.2	0.313	2,886,100
					70.8	0.227	3,122,200
					60.1	0.188	3,206,800
					49.5	0.148	3,335,800
					40.7	0.116	3,517,800
					30.1	0.078	3,848,100
					19.5	0.047	4,150,000
					15.0	0.031	4,810,200
					10.6	0.020	5,432,700
			23.0	10.0	123.8	0.344	3,601,400
					100.8	0.262	3,851,700
					90.2	0.227	3,981,100
					70.8	0.164	4,311,900
					60.1	0.137	4,398,100
					49.5	0.108	4,593,100

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-3	128.4	10.12	23.0	10.0	40.7	0.085	4,776,700
					30.1	0.061	4,933,800
					19.5	0.038	5,187,800
					15.0	0.028	5,345,000
					10.6	0.019	5,659,400
Class6-4	130.6	9.49	28.4	10.0	123.6	0.610	2,026,900
					100.6	0.485	2,076,400
					90.0	0.422	2,133,000
					70.6	0.305	2,316,400
					60.0	0.242	2,477,100
					49.4	0.188	2,634,900
					40.6	0.141	2,885,900
					30.0	0.094	3,199,500
					19.4	0.047	4,140,600
					15.0	0.023	6,399,100
			25.7	10.0	123.6	0.375	3,294,600
					100.6	0.281	3,577,000
					90.0	0.246	3,657,700
					70.6	0.188	3,765,300
					60.0	0.156	3,840,600
					49.4	0.121	4,081,100
					40.6	0.094	4,330,000
					30.0	0.063	4,800,700
					19.4	0.035	5,522,400
					15.0	0.023	6,400,900
					10.6	0.014	7,530,500
			23.0	10.0	123.6	0.301	4,107,700
					100.6	0.234	4,292,500
					90.0	0.207	4,347,900
					70.6	0.156	4,518,500
					60.0	0.129	4,655,400
					49.4	0.102	4,866,000
					40.6	0.078	5,196,200
					30.0	0.053	5,648,100
					19.4	0.031	6,212,900
					15.0	0.022	6,858,400
					10.6	0.013	7,973,700
Class6-6	133.1	8.92	26.6	10.0	120.1	0.469	2,560,300
					100.6	0.375	2,682,700
					90.0	0.328	2,743,200
					70.6	0.242	2,915,000
					60.0	0.188	3,200,400
					49.4	0.148	3,329,200
					40.6	0.114	3,558,800
					30.0	0.078	3,840,400
					19.4	0.045	4,284,500
					15.0	0.031	4,800,600

Sample no.	Dry Density (pcf)	Moisture content (%)	Temp (F)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-9	134.2	8.17	26.6	10.0	120.7	0.500	2,412,200
					101.1	0.406	2,488,600
					90.5	0.352	2,573,000
					71.0	0.258	2,751,800
					60.3	0.207	2,912,800
					49.7	0.164	3,027,000
					40.8	0.125	3,263,500
					30.2	0.086	3,508,600
					19.5	0.047	4,162,200
					15.1	0.034	4,385,700

CLASS 6 SUBBASE

Thawed

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-2	130.0	9.59	10.0	49.4	18.916	26,100
				40.6	17.422	23,300
				30.0	13.980	21,500
				20.3	10.490	19,400
				15.0	8.112	18,500
				10.6	6.363	16,600
				5.3	3.659	14,500
			7.0	28.3	13.903	20,300
				21.2	11.360	18,700
				14.1	8.805	16,000
				10.6	7.045	15,000
				7.1	5.284	13,400
				3.5	2.882	12,300
			4.0	20.3	10.596	19,200
				15.9	9.161	17,300
				12.4	8.036	15,400
				7.9	5.947	13,400
				4.0	3.536	11,200
				1.9	1.800	10,800
	130.0	5.95	10.0	49.4	11.827	41,800
				40.6	10.372	39,200
				30.0	8.428	35,600
				20.3	5.997	33,900
				15.0	4.765	31,500
				10.6	3.566	29,700
				5.3	1.880	28,200
			7.0	28.3	9.563	29,500
				21.2	7.780	27,200
				14.1	5.738	24,600
				10.6	4.538	23,300
				7.1	3.242	21,800
				3.5	1.751	20,200
			4.0	20.3	8.432	24,100
				15.9	7.135	22,300
				12.4	6.162	20,100
				7.9	4.475	17,800
				4.0	2.562	15,500
				1.9	1.297	15,000
Class6-3	128.4	10.12	10.0	49.5	14.563	34,000
				40.7	12.668	32,100
				30.1	10.609	28,300
				20.3	7.981	25,500
				15.0	6.176	24,300
				10.6	4.497	23,600
				5.3	2.375	22,300
			7.0	28.3	10.776	26,300
				21.2	8.875	23,900

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-3	128.4	10.12	7.0	14.2	6.815	20,800
				10.6	5.452	19,500
				7.1	3.867	18,300
				3.5	2.140	16,500
			4.0	20.3	8.410	24,200
				15.9	7.364	21,600
				12.4	6.507	19,000
				8.0	4.761	16,700
				4.0	2.857	13,900
				1.9	1.524	12,800
	128.4	8.88	10.0	49.5	10.168	48,700
				40.7	8.582	47,400
				30.1	6.834	44,000
				20.3	4.990	40,800
				15.0	3.973	37,800
				10.6	2.924	36,300
				5.3	1.589	33,400
			7.0	28.3	6.993	40,500
				21.2	6.198	34,200
				14.2	4.577	30,900
				10.6	3.623	29,300
				7.1	2.606	27,100
				3.5	1.399	25,300
			4.0	20.3	6.994	29,100
				15.9	6.040	26,400
				12.4	5.086	24,300
				8.0	3.624	22,000
				4.0	2.066	19,300
				1.9	1.081	18,000
	130.7	7.33	10.0	49.5	9.596	51,600
				40.7	8.317	48,900
				30.1	6.557	45,900
				20.3	4.670	43,600
				15.0	3.614	41,600
				10.6	2.687	39,500
				5.3	1.407	37,700
			7.0	28.3	6.878	41,100
				21.2	5.662	37,500
				14.2	4.095	34,600
				10.6	3.199	33,200
				7.1	2.239	31,600
				3.5	1.152	30,700
			4.0	20.3	6.078	33,500
				15.9	5.118	31,100
				12.4	4.223	29,300
				8.0	2.943	27,000
				4.0	1.599	24,900

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-3	130.7	7.33	4.0	1.9	0.800	24,300
Class6-4	130.6	9.49	10.0	49.4	11.772	42,000
				40.6	10.674	38,000
				30.0	8.163	36,800
				20.3	5.651	35,900
				15.0	4.395	34,100
				10.6	3.296	32,100
				5.3	1.790	29,600
			7.0	28.2	8.480	33,300
				21.2	7.224	29,300
				14.1	5.339	26,400
				10.6	4.303	24,600
				7.1	3.046	23,200
				3.5	1.633	21,600
			4.0	20.3	6.914	29,400
				15.9	5.971	26,600
				12.4	5.186	23,800
				7.9	3.929	20,200
				4.0	2.043	19,400
				1.9	1.037	18,700
	130.6	7.48	10.0	49.4	9.433	52,400
				40.6	8.176	49,700
				30.0	6.446	46,500
				20.3	4.559	44,500
				15.0	3.427	43,800
				10.6	2.516	42,100
				5.3	1.352	39,200
			7.0	28.2	6.761	41,800
				21.2	5.503	38,500
				14.1	4.088	34,500
				10.6	3.302	32,100
				7.1	2.264	31,200
				3.5	1.195	29,500
			4.0	20.3	6.132	33,100
				15.9	5.189	30,600
				12.4	4.403	28,100
				7.9	3.208	24,800
				4.0	1.793	22,200
				1.9	0.881	22,000
	133.8	7.15	10.0	49.4	8.494	58,200
				40.6	7.236	56,100
				30.0	5.820	51,600
				20.3	4.153	48,900
				15.0	3.303	45,400
				10.6	2.517	42,100
				5.3	1.321	40,100
			7.0	28.2	6.543	43,200

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-4	133.8	7.15	7.0	21.2	5.348	39,600
				14.1	3.932	35,900
				10.6	3.146	33,700
				7.1	2.202	32,100
				3.5	1.164	30,300
			4.0	20.3	5.663	35,800
				15.9	4.877	32,600
				12.4	4.153	29,700
				7.9	2.989	26,600
				4.0	1.573	25,200
				1.9	0.818	23,700
	133.8	6.51	10.0	49.4	8.814	56,100
				40.6	7.712	52,600
				30.0	6.170	48,600
				20.3	4.407	46,100
				15.0	3.525	42,600
				10.6	2.644	40,100
				5.3	1.416	37,400
			7.0	28.2	6.925	40,800
				21.2	5.666	37,400
				14.1	4.218	33,500
				10.6	3.337	31,700
				7.1	2.361	29,900
				3.5	1.228	28,800
			4.0	20.3	6.674	30,400
				15.9	5.666	28,000
				12.4	4.879	25,300
				7.9	3.431	23,100
				4.0	1.889	21,000
				1.9	0.944	20,600
Class6-5	128.7	9.28	10.0	40.5	12.559	32,300
				30.0	10.052	29,800
				20.3	7.540	26,900
				15.0	5.969	25,100
				10.6	4.398	24,000
				5.3	2.356	22,400
			7.0	28.2	10.696	26,400
				21.2	9.440	22,400
				14.1	6.923	20,400
				10.6	5.507	19,200
				7.1	3.934	17,900
				3.5	2.046	17,200
			4.0	20.3	9.465	21,400
				15.9	8.205	19,300
				12.3	6.944	17,800
				7.9	5.208	15,200
				4.0	3.062	12,900

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-5	128.7	9.28	4.0	1.9	1.578	12,300
	128.7	7.09	10.0	49.4	10.441	47,300
				40.5	8.704	46,600
				30.0	6.805	44,000
				20.3	4.747	42,700
				15.0	3.640	41,200
				10.6	2.595	40,700
				5.3	1.329	39,800
			7.0	28.2	7.914	35,600
				21.2	6.331	33,400
				14.1	4.432	31,800
				10.6	3.482	30,400
				7.1	2.374	29,700
				3.5	1.266	27,800
			4.0	20.3	7.282	27,800
				15.9	6.174	25,700
				12.3	5.224	23,600
				7.9	3.641	21,800
				4.0	1.900	20,900
				1.9	0.950	20,400
	128.2	5.13	10.0	49.4	9.729	50,700
				40.5	8.557	47,400
				30.0	6.656	45,000
				20.3	4.659	43,500
				15.0	3.550	42,200
				10.6	2.536	41,700
				5.3	1.331	39,700
			7.0	28.2	7.608	37,100
				21.2	6.023	35,100
				14.1	4.280	32,900
				10.6	3.329	31,800
				7.1	2.441	28,900
				3.5	1.268	27,800
			4.0	20.3	7.292	27,800
				15.9	6.024	26,300
				12.3	4.914	25,100
				7.9	3.488	22,700
				4.0	1.902	20,800
				1.9	0.983	19,700
	128.2	4.75	10.0	49.4	8.883	55,500
				40.5	7.772	52,100
				30.0	6.027	49,700
				20.3	4.346	46,600
				15.0	3.394	44,100
				10.6	2.538	41,700
				5.3	1.332	39,700
			7.0	28.2	7.296	38,600

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-5	128.2	4.75	7.0	21.2	5.964	35,500
				14.1	4.283	32,900
				10.6	3.394	31,100
				7.1	2.379	29,600
				3.5	1.269	27,800
			4.0	20.3	7.043	28,800
				15.9	5.869	27,000
				12.3	4.918	25,100
				7.9	3.553	22,300
				4.0	1.904	20,800
				1.9	0.952	20,400
Class6-6	133.1	8.92	10.0	15.0	6.137	24,400
				10.1	4.564	22,000
				7.1	3.620	19,500
				4.9	2.707	18,300
				3.5	2.077	17,000
			7.0	14.1	7.275	19,400
				10.6	6.012	17,600
				9.0	5.443	16,500
				7.1	4.557	15,500
				4.9	3.450	14,300
				3.5	2.595	13,600
			4.0	12.0	6.731	17,800
				10.1	6.268	16,100
				7.9	5.413	14,700
				4.9	3.980	12,400
				4.1	3.407	11,900
				1.9	1.847	10,500
	136.0	4.9	10.0	14.8	3.627	40,700
				9.9	2.564	38,600
				6.9	1.876	37,000
				5.0	1.407	35,800
				3.5	1.001	34,700
			7.0	14.1	4.284	32,800
				10.4	3.409	30,500
				9.0	3.065	29,400
				6.9	2.502	27,700
				5.0	1.876	26,800
				3.5	1.345	25,800
			4.0	12.0	4.973	24,100
				10.1	4.316	23,300
				8.0	3.597	22,200
				5.0	2.502	20,100
				4.0	2.064	19,300
				2.0	1.079	18,500
			2.0	6.1	3.410	17,800
				5.0	3.003	16,800

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-6	136.0	4.9	2.0	4.0	2.503	15,900
				3.0	2.002	14,700
				2.0	1.408	14,200
				1.0	0.766	13,600
	136.0	4.4	10.0	14.8	2.253	65,500
				9.9	1.565	63,200
				6.9	1.126	61,600
				5.0	0.845	59,600
				3.5	0.595	58,400
			7.0	14.1	2.566	54,800
				10.4	2.002	52,000
				9.0	1.783	50,600
				6.9	1.408	49,300
				5.0	1.048	48,000
				3.5	0.735	47,200
			4.0	12.0	2.785	43,000
				10.1	2.456	41,000
				8.0	2.065	38,700
				5.0	1.361	37,000
				4.0	1.079	37,000
				2.0	0.548	36,500
			2.0	6.1	1.924	31,600
				5.0	1.627	30,900
				4.0	1.314	30,400
				3.0	0.970	30,400
				2.0	0.657	30,400
				1.0	0.344	30,300
	133.3	1.55	10.0	14.3	1.907	75,000
				9.6	1.391	68,900
				6.7	1.016	66,200
				4.9	0.766	63,700
				3.4	0.531	63,300
			7.0	14.0	2.469	56,500
				10.6	2.000	53,000
				9.1	1.781	51,000
				7.1	1.453	48,600
				5.0	1.063	47,500
				3.5	0.766	46,100
			4.0	11.9	2.969	40,200
				10.1	2.656	38,000
				8.1	2.313	34,900
				5.0	1.625	31,000
				4.0	1.313	30,700
				2.0	0.672	30,000
			2.0	6.1	2.344	25,800
				5.0	2.094	24,100
				4.0	1.813	22,300

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-6	133.3	1.55	2.0	3.0	1.438	21,100
				2.0	1.000	20,200
				1.0	0.484	20,800
	133.8	0.73	10.0	15.0	1.063	140,800
				10.1	0.750	134,500
				7.1	0.531	132,900
				5.0	0.375	134,500
				3.5	0.250	141,200
			7.0	14.0	1.251	111,600
				10.6	0.977	108,400
				9.1	0.844	107,600
				7.1	0.672	105,100
				5.0	0.469	107,600
				3.5	0.320	110,200
			4.0	11.9	1.360	87,800
				10.1	1.188	84,900
				8.1	0.969	83,300
				5.0	0.617	81,700
				4.0	0.492	82,000
				2.0	0.227	89,000
			2.0	6.1	0.860	70,400
				5.0	0.719	70,200
				4.0	0.578	69,800
				3.0	0.422	71,700
				2.0	0.266	75,900
				1.0	0.125	80,700
Class6-9	134.2	8.17	10.0	15.1	7.221	20,900
				10.6	5.495	19,400
				7.1	3.925	18,100
				5.3	3.140	16,900
				3.5	2.198	16,100
			7.0	14.2	7.708	18,400
				10.6	6.295	16,900
				9.0	5.666	16,000
				7.1	4.879	14,500
				5.0	3.809	13,000
				3.5	2.896	12,300
			4.0	12.1	6.948	17,400
				10.1	6.320	16,000
				8.0	5.530	14,400
				5.0	4.045	12,300
				4.1	3.476	11,700
				2.0	1.896	10,300
	136.2	6.96	10.0	15.1	3.737	40,300
				10.6	2.787	38,200
				7.1	1.932	36,700
				5.0	1.394	35,600

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-9	136.2	6.96	10.0	3.5	1.013	35,000
			7.0	14.2	4.434	32,000
				10.6	3.516	30,300
				9.0	3.072	29,400
				7.1	2.534	28,000
				5.0	1.869	26,600
				3.5	1.330	26,700
			4.0	12.1	5.068	23,800
				10.1	4.498	22,500
				8.0	3.801	21,000
				5.0	2.534	19,600
				4.1	2.154	18,900
				2.0	1.030	19,000
	136.2	6.08	10.0	15.1	3.455	43,600
				9.9	2.440	40,700
				7.1	1.807	39,300
				5.0	1.284	38,700
				3.5	0.919	38,600
			7.0	14.2	4.089	34,700
				10.6	3.297	32,300
				9.0	2.884	31,400
				7.1	2.346	30,300
				5.0	1.712	29,000
				3.5	1.236	28,700
			4.0	12.1	4.660	25,900
				10.1	4.121	24,500
				8.0	3.455	23,100
				5.0	2.346	21,200
				4.1	1.981	20,600
				2.0	0.967	20,200
	136.2	5.38	10.0	15.1	3.173	47,500
				9.9	2.221	44,700
				7.1	1.650	43,000
				5.0	1.174	42,300
				3.5	0.841	42,200
			7.0	14.2	3.808	37,300
				10.5	2.983	35,100
				9.0	2.650	34,100
				7.1	2.158	32,900
				5.0	1.587	31,300
				3.5	1.158	30,600
			4.0	12.1	4.348	27,700
				10.1	3.840	26,300
				8.0	3.237	24,700
				5.0	2.221	22,400
				4.1	1.841	22,200
				2.0	0.904	21,600

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-9	135.3	3.95	10.0	14.9	2.657	56,100
				10.0	1.876	53,300
				7.0	1.376	51,000
				5.1	1.016	50,000
				3.5	0.719	48,800
			7.0	14.2	3.283	43,300
				10.5	2.626	40,000
				9.1	2.345	38,900
				7.0	1.876	37,400
				5.1	1.407	36,100
				3.5	1.000	35,000
			4.0	12.1	3.751	32,200
				10.2	3.282	31,000
				8.1	2.782	29,000
				5.1	1.938	26,200
				4.0	1.563	25,800
				2.0	0.813	24,800
			2.0	6.1	2.845	21,600
				5.1	2.470	20,600
				4.0	2.063	19,500
				3.0	1.594	18,700
				2.0	1.125	17,900
				1.1	0.594	17,700
	135.3	1.4	10.0	14.9	1.750	85,000
				10.0	1.250	79,800
				7.0	0.922	75,900
				5.1	0.695	73,000
				3.5	0.484	72,200
			7.0	14.2	2.078	68,200
				10.5	1.688	62,200
				9.1	1.500	60,700
				7.0	1.195	58,500
				5.1	0.906	56,000
				3.5	0.633	55,300
			4.0	12.1	2.391	50,500
				10.2	2.172	46,700
				8.1	1.813	44,400
				5.1	1.250	40,600
				4.0	1.016	39,600
				2.0	0.500	40,200
			2.0	6.1	1.813	33,800
				5.1	1.563	32,500
				4.0	1.313	30,700
				3.0	1.000	29,700
				2.0	0.664	30,300
				1.1	0.344	30,500
	136.3	0.47	10.0	14.9	1.172	126,900

Sample no.	Dry Density (pcf)	Moisture content (%)	Confining pressure (psi)	Deviator Stress (psi)	Axial strain x10^-4 (in/in)	Resilient modulus (psi)
Class6-9	136.3	0.47	10.0	10.0	0.820	121,600
				7.0	0.594	117,900
				5.1	0.438	116,000
				3.5	0.289	121,100
			7.0	14.2	1.422	99,700
				10.5	1.141	92,000
				9.1	1.016	89,600
				7.0	0.805	87,000
				5.1	0.586	86,600
				3.5	0.398	87,800
			4.0	12.1	1.781	67,800
				10.2	1.609	63,100
				8.1	1.375	58,500
				5.1	0.953	53,200
				4.0	0.750	53,700
				2.0	0.359	56,000
			2.0	6.1	1.531	40,000
				5.1	1.359	37,300
				4.0	1.125	35,800
				3.0	0.859	34,600
				2.0	0.586	34,300
				1.1	0.281	37,300

APPENDIX B: SUBSTITUTE MATERIALS RESILIENT MODULUS TEST RESULTS

DENSE GRADED STONE

Frozen

Dry Density (psi)	Moisture Content (%)	Temp (F)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
111.6	21.78	24.6	10.0	40.7	0.077	5,283,800
				50.5	0.129	3,912,100
				70.1	0.231	3,032,000
				89.5	0.463	1,932,900
				122.1	0.514	2,375,100
		31.1	10.0	10.2	0.038	2,688,300
				20.4	0.180	1,135,400
				29.4	0.333	883,100
				40.8	0.411	993,300
		31.8	10.0	10.2	0.437	233,500
			4.0	5.9	0.437	134,900
				8.2	0.308	265,400
				9.8	0.411	237,800
			7.0	6.8	0.218	314,700
				10.6	0.463	229,100
				13.9	0.720	192,900
				17.9	0.951	188,500
114.3	16.09	17.2	10.0	49.9	0.061	8,176,600
				69.2	0.122	5,671,000
				88.5	0.195	4,538,500
				120.7	0.293	4,119,500

DENSE GRADED STONE

Thawed

Dry Density (psi)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
122.9	6.25	2.0	1.5	1.896	7,900
			2.0	2.168	9,000
		4.0	2.0	1.491	13,100
122.9	5.50	1.0	1.0	0.433	22,600
			1.5	0.731	20,500
			2.0	0.947	20,600
			2.4	1.218	20,000
		2.0	1.0	0.379	25,800
			2.0	0.866	22,500
			2.9	1.353	21,600
			3.9	1.759	22,200
			4.9	2.220	22,000
		4.0	2.0	0.704	27,700
			3.9	1.489	26,200
			6.0	2.302	26,200
		7.0	7.0	2.168	32,300
			10.2	3.255	31,200
131.8	16.00	1.0	1.0	0.946	10,700
			1.5	1.353	11,100
		2.0	1.0	0.596	16,400
			1.9	2.171	8,900
131.8	6.00	1.0	0.5	0.243	19,900
			1.0	0.514	18,800
			1.5	0.838	17,700
			1.9	1.216	15,900
			2.4	1.406	17,200
		2.0	1.0	0.514	18,800
			1.9	1.054	18,400
			2.9	1.487	19,500
			3.9	1.893	20,400
		4.0	1.9	0.784	24,700
			3.9	1.758	22,000
			6.0	2.569	23,200
135.4	8.50	1.0	0.5	0.514	9,400
			1.0	1.081	8,900
			1.5	1.677	8,800
		2.0	1.0	0.757	12,800
			1.9	1.758	11,000
		4.0	1.9	1.272	15,200
135.4	6.00	1.0	1.0	0.460	21,000
			1.5	0.785	18,900
			1.9	1.137	17,000
			2.4	1.489	16,200
		2.0	1.0	0.379	25,500
			1.9	0.948	20,400
			3.0	1.408	21,100
			3.9	2.085	18,500

Dry Density (psi)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
135.4	6.00	4.0	1.9	0.731	26,400
			3.9	1.680	23,000
			6.0	2.710	22,000
135.4	5.50	1.0	1.5	0.596	24,800
			1.9	0.949	20,400
			2.4	1.274	19,000
		2.0	1.0	0.407	23,700
			1.9	0.949	20,400
			3.0	1.356	22,000
			3.9	1.898	20,400
			5.0	2.441	20,400
		4.0	1.9	0.759	25,500
			3.9	1.681	23,000
			6.0	2.576	23,100
			8.0	3.310	24,300
		10.0	9.7	2.986	32,300
			19.3	7.070	27,300

TAXIWAY A SUBBASE

Frozen

Dry Density (psi)	Moisture Content (%)	Temp (F)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^-4 (in/in)	Resilient Modulus (psi)
126.0	7.50	23.0	10.0	19.7	0.042	4,695,100
				29.9	0.083	3,598,900
				39.6	0.139	2,844,900
				49.2	0.264	1,863,300
				70.3	0.486	1,447,100
		28.0	10.0	19.8	0.139	1,422,500
				29.9	0.361	828,000
				39.6	0.639	619,100
				49.2	0.973	506,100
		31.6	4.0	1.9	1.113	17,400
				3.9	2.646	14,500
				5.8	4.184	14,500
			10.0	9.7	6.294	16,000
				19.8	11.230	17,400
130.9	7.50	29.1	10.0	29.8	0.250	1,191,900
				39.4	0.417	945,400
				49.0	0.584	838,100
		23.0	10.0	10.1	0.056	1,798,000
				19.7	0.097	2,031,500
				29.8	0.139	2,143,100
				39.4	0.222	1,774,800
				49.1	0.250	1,961,900
				70.1	0.361	1,941,600
		16.2	10.0	9.6	0.019	5,070,700
				19.7	0.051	3,864,300
				29.8	0.077	3,868,600
				39.4	0.109	3,616,300
				49.1	0.180	2,724,600
				70.1	0.295	2,375,100
		31.1	10.0	9.6	0.108	891,800
				19.7	0.257	765,600
				29.8	0.405	735,200
				39.4	0.568	694,600
				49.1	0.811	604,700
127.5	7.50	23.0	10.0	19.7	0.042	4,698,000
				29.8	0.083	3,591,700
				39.5	0.125	3,158,100
				49.1	0.181	2,713,000
				70.2	0.361	1,943,000
		29.5	10.0	10.1	0.069	1,461,600
				19.7	0.153	1,290,500
				29.8	0.333	894,700
				39.5	0.667	591,600
				49.1	1.001	490,100
		16.2	10.0	19.7	0.053	3,723,600
				29.8	0.105	2,839,100
				39.5	0.158	2,498,400

Dry Density (psi)	Moisture Content (%)	Temp (F)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^-4 (in/in)	Resilient Modulus (psi)
127.5	7.50	16.2	10.0	49.1	0.210	2,338,900
				70.2	0.329	2,133,000
		31.1	10.0	19.7	0.184	1,073,000
				29.8	0.316	944,000
				39.5	0.474	832,300
				49.1	0.684	717,800

TAXIWAY A SUBBASE

Thawed

Dry Density (pcf)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
130.9	7.50	1.0	0.5	0.915	5,200
			1.0	1.961	4,900
			1.4	2.943	4,900
		2.0	1.0	1.380	7,000
			1.9	2.747	7,000
		4.0	1.9	1.701	11,300
126.3	6.50	1.0	0.5	0.353	13,100
			0.9	0.882	10,700
			1.4	1.412	10,300
			1.9	1.942	9,900
			2.5	2.649	9,500
		2.0	1.0	0.706	14,000
			2.0	1.589	12,500
			2.9	2.355	12,300
			4.0	3.179	12,500
		4.0	2.0	1.119	17,700
			4.0	2.297	17,200
126.3	6.00	1.0	0.5	0.353	14,000
			1.0	0.706	14,000
			1.5	1.059	14,000
			2.0	1.530	13,000
			2.5	2.000	12,400
			2.5	1.941	12,700
		2.0	1.0	0.471	21,000
			2.0	1.177	16,800
			3.0	1.883	15,800
			4.0	2.648	15,000
		4.0	2.0	0.765	25,900
			4.0	1.883	21,000
			5.9	2.945	20,200
			7.9	4.122	19,200
		10.0	4.9	1.472	33,600
			9.9	3.064	32,300
127.0	5.50	1.0	1.0	0.514	19,300
			1.5	0.857	17,400
			2.0	1.200	16,500
			2.5	1.543	16,100
		2.0	1.0	0.400	24,800
			2.0	1.200	16,500
			3.0	1.600	18,600
			4.0	2.229	17,800
			5.0	2.972	16,700
		4.0	2.0	0.800	24,800
			4.0	1.772	22,400
			6.0	2.743	21,700
			7.9	3.716	21,400
		10.0	5.0	1.258	39,500

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Dry Density (pcf)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
127.0	5.50	10.0	9.1	2.744	33,200
127.5	7.50	1.0	0.5	0.667	7,100
			1.0	1.455	6,500
			1.4	2.243	6,400
		2.0	1.0	1.273	7,500
			1.9	2.304	8,300
			2.9	3.458	8,300
		4.0	1.9	1.577	12,100
			3.8	3.338	11,400
127.5	6.50	1.0	0.5	0.572	8,300
			1.0	1.306	7,300
			1.4	2.041	7,000
			1.9	2.776	6,800
		2.0	1.0	0.980	9,700
			1.9	2.042	9,300
			2.9	3.186	8,900
		4.0	1.9	1.307	14,500
			3.8	2.860	13,300
129.8	6.00	1.0	0.5	0.353	14,500
			1.0	0.765	13,000
			1.5	1.236	12,400
			2.0	1.648	12,400
			2.6	2.119	12,100
		2.0	1.0	0.706	14,000
			3.1	2.119	14,500
			4.1	3.003	13,600
		4.0	2.0	1.001	20,500
			4.1	2.179	18,800
129.8	6.00	4.0	6.1	3.358	18,300
			8.2	4.716	17,400
		10.0	4.8	1.651	28,900
			10.2	3.539	28,900
129.7	5.50	1.0	0.5	0.236	21,700
			1.0	0.531	18,600
			1.5	0.885	17,400
			2.0	1.180	17,300
			2.6	1.592	16,100
		2.0	1.0	0.531	18,600
			2.0	1.062	19,300
			3.1	1.652	18,600
			4.1	2.182	18,800
			5.1	2.714	18,900
		4.0	2.0	0.944	21,700
			4.1	1.770	23,100
			6.1	2.655	23,100
			8.2	3.540	23,100
		10.0	5.1	1.298	39,400

Dry Density (pcf)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
129.7	5.50	10.0	10.2	2.951	34,700
126.0	7.50	1.0	0.5	0.572	8,500
			1.0	1.201	8,100
			1.5	2.132	6,900
		2.0	1.0	0.948	10,200
			2.0	2.074	9,600
			2.9	3.083	9,500
		4.0	2.0	1.482	13,400
			4.0	2.966	13,400
			5.9	4.453	13,200
126.0	6.50	1.0	1.5	1.143	12,900
			2.0	1.714	11,600
			2.4	2.286	10,600
		2.0	2.0	1.315	15,100
			2.9	1.829	16,100
			4.0	2.801	14,200
			4.8	3.716	13,000
		4.0	2.0	0.915	21,700
			4.0	2.173	18,300
			6.0	3.431	17,600
			7.9	4.577	17,400
		10.0	4.8	1.602	30,200
			9.5	3.434	27,700
129.1	6.00	1.0	0.5	0.342	14,400
			1.0	0.737	13,400
			1.5	1.158	12,900
			2.0	1.579	12,800
			2.5	2.000	12,300
		2.0	1.0	0.605	16,300
			2.0	1.263	16,000
			3.0	1.895	15,800
			4.0	2.632	15,400
			4.9	3.422	14,400
		4.0	2.0	1.000	20,200
			4.0	2.000	20,200
			6.0	3.001	19,900
			8.1	4.055	19,900
		10.0	4.9	1.422	34,600
			10.5	3.206	32,900
129.1	5.50	1.0	0.5	0.211	23,300
			1.0	0.474	20,800
			1.5	0.789	18,900
			2.0	1.105	18,300
			2.5	1.421	17,300
		2.0	1.0	0.447	22,000
			2.0	1.000	20,200
			3.0	1.526	19,600

Dry Density (pcf)	Moisture Content (%)	Confining Pressure (psi)	Deviator Stress (psi)	Axial Strain x10^4 (in/in)	Resilient Modulus (psi)
129.1	5.50	2.0	4.0	2.053	19,700
			4.9	2.474	19,900
		4.0	2.0	0.842	24,000
			4.0	1.737	23,300
			6.0	2.632	22,700
			8.1	3.422	23,600
		10.0	4.9	1.369	35,900
			10.5	3.002	35,100

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Richard L. Berg, Susan R. Bigl, Jeffrey A. Stark and Glenn D. Durell

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72 Lyme Road
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13. ABSTRACT *(Maximum 200 words)*

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) conducted resilient modulus tests on materials from the Mn/ROAD test site for the Minnesota Department of Transportation. Materials tested included samples of the lean clay subgrade at the site and the two extreme grades of base designed specifically for Mn/ROAD. Some specimens were tested in both frozen and subsequently "thawed" conditions; others were tested at room temperature without ever having been frozen. Researchers performed linear regression analysis on the data to develop equations that predict frozen modulus based on unfrozen water content and unfrozen modulus based on stress, degree of saturation and density. We also reanalyzed data from two previously tested materials. CRREL can use the study's equations in the Mechanistic Pavement Design and Evaluation Procedure under development at CRREL to predict estimated damage in some Mn/ROAD test sections.

14. SUBJECT TERMS

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